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Greenhouse Potted Plants

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GREENHOUSE POTTED PLANTS

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INTRODUCTION

The demand for flowering pot plants has steadily increased during the past decade. To maintain this demand it is necessary that growers produce plants of the highest quality. Since large crops are grown for specific days, particularly Christmas and Easter, it is of the greatest importance that growers know the exact cultural requirements. With few exceptions, growers of pot plants are confronted with the problem of producing several kinds of plants within the same house; this makes it imperative that they be thoroughly familiar with the particular needs of each crop.

The discussion of the major potted plants and their culture as presented in this bulletin is based upon the best accepted commercial practices, together with the results of experimental work conducted for several years at the Ohio Agricultural Experiment Station and the Ohio State University.

EQUIPMENT

For economical production of potted plants, proper equipment and arrangement should be given considerable thought and planning.

HOUSES

The most satisfactory width of house depends on the specific crop grown. Houses 10 to 28 feet in width have been found decidedly advantageous. Houses 24 to 35 feet wide are preferred where pot plants and cut flower crops are grown together.

The length of the house is not as important as the width. Houses about 100 feet in length are desirable for pot plants because the temperature over the entire house can be regulated more easily. Temperatures often vary as much as 10 degrees at the opposite ends of the house, and if such a condition prevails, constant shifting of plants becomes necessary. Either detached or ridge and furrow houses may be used satisfactorily.

BENCHES

The arrangement of the benches depends upon the width of the house. Usually, 5-foot benches are better than the narrower 3-foot 8-inch type. The height of the bench should be between 24 and 33 inches.

Tile, concrete, or wood may be used for the construction of benches. Tile benches with wood side boards are satisfactory. Tile conducts the heat very rapidly, is long lasting, and lends itself to cleaning very easily. Tile is more readily moved than concrete. The use of a 3½-inch side rail makes a bench which is sturdy and economical for pot plant culture. Tile is more satisfactory for propagating benches than wood or concrete. Wood benches are cheaper to build, but are not lasting and harbor pests more readily. Concrete benches are lasting.

WORKROOM

Many workrooms are not equipped with good, substantial potting benches. The potting bench should be of the proper height for efficiency. The room should be well lighted, centrally located, and fully equipped with bins for storing the various-sized pots, the fertilizers, humus, soil, and trash.

POTS

The pots used for most greenhouse operations are the standard, three-quarter, and pan types, ranging in size from 1 to 12 or 14 inches. Standard-sized pots are more often preferred for deeper-rooted plants, such as Cineraria and Genista. Three-quarter–sized pots and pans are used for the shallow-rooted plants, such as Azalea, Kalanchoe, Poinsettia, and bulbs. The most satisfactory pots are made of clay and have one or more drainage holes in the bottom. Wooden containers are more attractive to the retailer and many are being used in place of clay pots in the finishing stages. Fiber pots have a tendency to decompose through the action of bacteria working on the cellulose. The bacteria also use the nitrogen in the soil for their food and thus check plant growth. Pots impervious to air and moisture have been tried and proved satisfactory, provided extreme caution is used in the application of water. Concrete pots are also finding a limited use. A good pot should be strong, light in weight, and fairly porous, although the need of porosity for best results has not been definitely proved.

SPRAYERS

The knapsack sprayer has given way to the power sprayer because higher pressures are necessary to secure proper coverage of foliage quickly and thoroughly.

The following points should be considered when purchasing a power sprayer.

1. It should be capable of developing 200 to 300 pounds of pressure.
2. It should be able to handle at least two lines of hose.
3. It should maintain a fairly constant pressure. (There should not be over 10 to 20 pounds of variation).
4. It should have an efficient agitator to keep spray in suspension.
5. It should be easily cleaned and cared for.
6. It should have spray rods and nozzles adapted for greenhouse work. Orchard spray rods and spray guns are too wasteful of material for greenhouse spraying.
7. The pressure should be easily adjusted.
8. A pressure gauge should be part of the equipment.
9. The spray tank should be easily drained.

SOIL SHREDDERS

Shredders are useful in preparing soil for the small plants, which require screened soil. For larger plants, shredding the soil fine often proves harmful, although this depends on the type of soil. Many growers prefer the shovel method of preparing soils for pot plants because it does not make the soil too fine, yet makes it of good structure.

BULB STORAGE

A small building constructed to hold the temperature above freezing during the coldest weather is satisfactory for bulb storage. With ventilators located on top and at the bottom, the air and temperature can be regulated easily. For potted bulbs, shelves 15 to 18 inches high should be made to accommodate the maximum number of pots. With the aid of a refrigerator and fan the storage can be kept at any desirable temperature.

COLDHOUSE OR SHED

With pot plants it is necessary to have some building where low temperatures may be maintained to hold back and harden plants before shipping to the retailer. Usually a north lean-to with a part board and glass roof fills the need.

STEAM STERILIZERS

A suitable box made of wood or sheet iron, sufficiently tight to hold the soil and heat, will suffice for a sterilizer. The inlets are placed on the bottom; the number of perforated lines will depend on the size of the box. If the box is constructed to handle loose soil, the perforated mains should be placed in 3-inch tile so that the moisture of condensation will drain and not puddle the soil. The box should not be over 24 inches high if soil is placed in the box loose and not over 36 inches high when flats are used.

FRAMES

Frames and sash are important equipment where miscellaneous pot plants are grown. During the early fall, frames make ideal growing conditions for pot Chrysanthemums and later, for the hardening off of Hydrangeas. In the spring, bulbs and bedding stock are easily grown in heated frames.

MANAGEMENT

Successful management of a pot plant range depends on proper rotation of crops and complete occupancy of bench space at all times. Success further depends upon the ability of the grower to regulate the temperature, light, water, and air. Timing crops must be understood. The weather conditions are important in timing crops for Easter and Mother's Day, especially. Temperatures should be watched day and night. The condition of the stock should be judged daily in the light of the prevailing weather conditions. For instance, the buds of Lilies should be seen at least 4 weeks before Easter delivery, under normal weather conditions, to bring the crop in on time in a temperature of 65° F. On rambler roses the buds should be showing color 2 weeks before the date of delivery to be in good shape for sale.

POTTING AND SHIFTING

Potting refers to the placing of seedlings or larger plants into pots; shifting is the transferring of the plant from one size to another, usually to a larger-size pot.

Potting and shifting are the most important mechanical operations in the commercial pot plant range. Skill in potting is attained through practice and close observation of the needs of plants. Such plants as geraniums require very hard potting; whereas Cyclamen and Begonias do better with less packing of the soil.

For small seedlings fill the pot to overflowing with soil; one dab with the forefinger or dibble will make a hole large enough for the plant. If the roots are too large, hold the plant with the first two fingers and thumb and fill the pot with one handful of soil. Then, holding the thumb and first finger of both hands close to the side of the pot, press the soil firmly. After a slight circular movement of the pot the same procedure should again be carried out. This will make the soil firm about the roots of the plant. Then, tap the pot on the bench and place it in a flat. This will settle the soil some, and the first watering will do the rest.

When shifting larger plants, hold the plant by the stem and place enough soil in the pot to bring the top of the ball within ½ or ¾ inch of the rim of the pot. The plant can be kept in place much more easily if the small finger is placed on the rim of the pot. Tilt the plant slightly and fill the pot with soil. Give the pot a half turn; again lean the plant toward you; and fill up the over side. Then squeeze the ball down firmly. Another rap on the bench, and the soil is solid all around the ball and firm near the bottom. For small shifts it is advisable to make the soil compact about the ball with a stick.

For potting, the soil should be medium moist. The correct consistency may be ascertained by taking a handful of soil and squeezing it. If it adheres in a ball but crumbles when allowed to drop to the bench, it will have the right moisture content.

When potting plants difficult to grow, it is advisable to have one man pot them all. By doing this, all the plants will be potted in the same manner, and the plants will dry out more evenly than if two or more men do the potting. It is necessary to allow the same space for water in every pot. It does not take much variation in the soil level to cause difficulty because some plants receive much more water than others.

New pots should always be sprinkled or dipped into water before using. The unused pot will absorb large amounts of water and if not moistened will take up the moisture from the soil of the newly potted plant.

WATERING AND SYRINGING

It is a known fact that silt loam soils require less frequent applications of water than sandy types because there are a larger number of particles in the silt loam soil. The ideal moisture condition for most plants is a uniform amount of water at all times. Wiggin (8) found that Chrysanthemums grown in wet soil produced a larger green weight than those in medium moist and dry conditions. The belief that plants should be allowed to become rather dry and then be given water is not correct for all plants.

Watering depends upon the type of root system of the plant, the age of the plant, and the season of the year. A thorough soaking is necessary after potting or shifting. Further additions will increase in frequency as the plants become more and more pot-bound. The type of soil mixture in which the plants are growing will, of course, necessitate varying the amount of water needed. Soils containing peat will retain more moisture than soils containing well-rotted manure.

The experienced grower can tell by tapping a pot and noting the sound whether or not the plant is dry. A wet soil will sound dull; a dry one will give a distinct hollow ring. Overhead watering should be avoided in most instances and especially in the case of such plants as Saintpaulia, Gloxinia, and others with thick, pubescent foliage.

Seed plants and seed flats should be watered by placing in a pan of water and allowing moisture to rise by capillarity.

During sunny days the plants should be syringed and the walks wet frequently to maintain a moist atmosphere favorable for plant growth.

VENTILATION

Ventilation is used primarily to keep down the temperature when the sun's rays have heated the houses, but it is also useful in supplying oxygen and carbon dioxide to the plants during the winter months.

Avoidance of drafts and sudden changes of temperature is essential in proper ventilation. Ventilating should be started early in the day, and the air intake should be reduced gradually in the afternoon. On bright days the ventilators should be opened early and gradually to prevent sudden changes in temperature.

TEMPERATURE

Most pot plants have definite optimum temperature requirements, and if these are not properly maintained, unhealthy plants result. The regulation of temperature to hasten development should be thoroughly understood before it is used. High temperatures often cause soft, succulent growth.

Thermometers should be placed in each house. It is likewise advisable to check the different locations in each house frequently, because considerable variation may occur.

SHADING

The term shading as used here pertains to reducing the light intensity and not the length of day. The proper manipulation of shade is necessary in growing pot plants. Too heavy a shade induces soft growth and makes the plant more susceptible to disease. Gloxinias, Saintpaulias, and the like are benefited by a double shade, that is, using muslin directly over the plants in addition to whitening on the glass. Using aster cloth in addition to shading the glass makes a better growing condition for plants which sunburn easily.

HUMIDITY

Humidity is regulated by syringing the plants and walks. Some plants, such as the Kalanchoe, will grow better if the humidity is not too high, but Gardenias and Hydrangeas do much better in moist atmosphere. The Hydrangea will develop shorter shoots when grown in low humidity; this may be an advantage.

SOILS

The function of any soil, in its relation to plants, is principally four-fold. It supplies the plant with a means of physical support; it serves as a water reservoir; it contains mineral elements essential to plant growth; and it furnishes a healthy environment for the roots, being plentifully supplied with oxygen and free from substances toxic to the plant. The ideal soil for any particular plant is that soil which most nearly fits the requirements of the plant.

Soil is made up of particles of mineral matter of varying sizes more or less coated with organic matter. The term texture applies to the size of the particles. Whether a soil is a silt loam, sandy loam, or fine sandy loam depends on the amounts of the various-sized particles. A silt loam contains less than 20 per cent of clay and over 50 per cent of silt. Silt and clay soils are generally referred to as heavy soils.

To identify the various types of soil is extremely difficult for the average person. The soil in the State of Ohio is between 80 and 85 per cent silt loam. Silt loam will form hard lumps when air-dried. Considerable pressure is required to break it into small clods or coarse granules by hand, and these granules may be further reduced to fine granules by the same method. It is impossible to granulate clay soils treated in this manner.

Additions of sand will change the texture of the soil, making it lighter and more workable. Approximately 20 per cent of humus and 30 per cent of sand are required to change a clay soil to a good, porous silt loam. Not all clay soils will respond alike, and experiments with various percentages of humus and sand should be carried out before using such a mixture on a large scale.

The field preparation of soil is preferred to the compost pile method. By correcting the acidity with ground limestone to the correct range one can grow a cover crop of either soybeans or red clover. Superphosphate should be applied in the field before working. Organic matter aids in maintaining a granulated soil.

After obtaining a good basic soil with a fair amount of organic matter, one can easily vary the soil mixture. Exact soil mixtures are not as important as many growers believe. Good plants have been grown in sand with weekly applications of nutrient solution; however, to simplify watering, fertilizing, and care in general, it is much better to start with a soil mixture that has been found suitable for each particular crop. One must study the different plants to determine the proper mixture. The Poinsettia requires a soil which drains rapidly; therefore, no peat should be added to the soil mixture; for Cyclamen, peat is desirable.

Rotted manure, leaf mold, peat, and sharp sand are the other materials which are frequently used in soil mixtures. Leaf mold should not be of oak leaves, as oak leaves contain considerable amounts of tannic acid, which is detrimental to many plants, especially Begonias. Leaf mold may be infested with nematodes; so its source should be determined before use. Imported sphagnum peat, uniform in structure, has given better results than domestic sedge peats. It will not decompose as rapidly as the domestic kinds. Well-rotted cow manure is preferred to any other kind of manure. Sand should be coarse and acid or alkaline, depending on the crop grown. For Azalea culture, acid sand should be used.

SOIL REACTION

Soil acidity is a condition which exists when the basic elements, such as calcium, magnesium, sodium, and potassium, have been absorbed by the plant or leached away, leaving behind iron, silicon, aluminum, and sulfates with which they are combined. This undersupply of bases produces an acid reaction which may be injurious to plants.

For the sake of safety, slightly acid soils are most suitable for greenhouse pot plants because under such conditions the various elements needed for plant growth are available and the slight degree of acidity is not sufficient to discourage the development of beneficial bacteria. To secure such a reaction in

the soil it is necessary to know the materials, the amounts to apply, and the methods of determining the state of soil reaction. Without going into technicalities, it should be understood that the term "pH" is a designation of a scale in which 7 is the neutral point. All numbers below show acidity, and those above indicate alkalinity. Thus, pH 6.5 means slightly acid; pH 5, very acid; pH 7.5, alkaline; and pH 8, very alkaline. The majority of greenhouse crops are grouped in the range of 6 to 6.5. When the soil is 5 or below, only such plants as Azaleas, Gardenias, and Hydrangeas may grow satisfactorily. When the soil reaction gets above 7.5 the great majority of florist's crops will suffer.

Forms of lime, usually ground limestone, sometimes dolomitic limestone, are used to counteract acidity. Occasionally calcium chloride and agricultural slag are also recommended for specific ailments. The recommendation for the most common material, calcium carbonate or ground limestone, is as follows: to raise pH 5 to pH 6 on sandy loams requires about 2500 pounds to the acre, or about 5 pounds to 100 square feet of bench space. To raise pH 6 to pH 6.5 takes an additional 500 pounds to the acre, or about 1 pound to 100 square feet, and to bring it to the neutral point (pH 7) takes another 300 pounds. On a heavier soil, like a silt loam, it takes 3440 pounds to the acre to change from 5 to 6, 1000 pounds more to the acre to change from 6 to 6.5, and 600 pounds more to bring the pH to the neutral point. Clay loams require about 4250 pounds of limestone to change from 5 to 6, 1500 pounds more to change from 6 to 6.5, and 800 pounds more to bring the soil to the neutral point.

It should be understood that these amounts are not exact, since no two soils react the same to the additions of lime, but for general purposes they are accurate enough. To convert pounds to the acre, it is figured roughly that 1000 pounds to the acre equals about 2 pounds to 100 square feet of bench space.

If hydrated lime is used, two-thirds of the above-recommended amounts will suffice. However, its action is quick but not lasting and care should be used in its application when it is combined with manures or other nitrogenous fertilizers, since damage may occur from rapid release of ammonia.

Alkaline soils may be made acid through the use of such materials as flowers of sulfur or aluminum sulfate. The sulfur is safer to use but does not produce the necessary reaction as quickly as aluminum sulfate. In soils lacking in phosphorus, the liberation of free aluminum may cause damage. Where phosphorus is abundant such damage rarely occurs, because of the combination of aluminum with phosphorus into an insoluble aluminum phosphate.

In an average medium light silt loam it takes 4½ pounds of aluminum sulfate to 100 square feet of bench soil to bring the reaction down from pH 8 to pH 7 and requires approximately 2 weeks for the process. Nine pounds for the same area are needed to bring it down to pH 6.0, and 13½ pounds, to bring it to 5.5.

If flowers of sulfur were used, 2 pounds to 100 square feet of bench soil would bring the reaction from pH 8 to pH 7 in 6 weeks. To get it down to pH 6.5, 3 pounds to 100 square feet would be required, and the time needed would be about 8 or 9 weeks. To get the reaction down to pH 6, 4 pounds would be needed for the same length of time.

Once these limits are reached, the soil reaction would remain constant were it not for the leaching and the applications of alkaline water, which necessitate additions of acidifying materials at regular intervals. These cannot be predicted, but regular tests for acidity will bring out the need.

FERTILIZERS

To produce good-quality crops without the proper nutrients in the soil is impossible. Nitrogen, phosphorus, potassium, manganese, calcium, iron, sulfur, and a few other, minor elements are essential and should be supplied in sufficient amounts for proper plant growth. The first three mentioned are used by the plant in large amounts, and, consequently, are often lacking.

Fertilizers are either organic or inorganic. Organic fertilizers are the remains of partially decomposed plant or animal matter. They are more slowly available and can be applied with greater safety than inorganic fertilizers. Inorganic fertilizers are more readily available and contain a higher percentage of nutrients; therefore a greater degree of care must be taken in their use. However, they are usually less expensive.

Microchemical soil tests for available nitrogen, phosphorus, and potassium should be made regularly to determine the nutrients necessary.

Finally, the best results obtainable may be had by following the simple formula of knowing plants, their requirements, and their enemies. A few rules will amplify this statement:

1. Start with a good-textured soil with sufficient humus and nutrients.
2. Apply fertilizers when light is abundant so that the necessary processes of food manufacture within the plant can take place.
3. In the fall before the advent of dark days use organic materials.
4. Use the concentrated fertilizers when the soil is moist and the plants are turgid.
5. Do not overfertilize.
6. Test the soil frequently and correlate the test results with the condition of the plant before applying fertilizer.
7. Acidity of soil is very important, especially in the availability of elements to the plants.

SYMPTOMS OF NUTRIENT DEFICIENCIES

Although all plants do not show symptoms of the lack of various elements in the soil in exactly the same manner, it is possible to make some generalizations which apply in many instances.

In general, nitrogen deficiency is evidenced by light color of the foliage, which remains on the plant, small leaves soft in texture, woody stems, short internodes, and small flowers. Lack of phosphorus is indicated usually by marginal leaf yellowing or abnormal leaf coloring, dropping of foliage, weak stems, poor root systems, and general stunting. Potassium deficiency results in marginal browning of foliage, which later turns to brown, purpling of the under surface of the leaves, dropping of leaves eventually, weak stems, and poor color of flowers. Manganese and iron deficiencies resemble each other closely, showing a marked reduction of color between leaf veins, which are strongly intensified. Yellowing of the foliage of Hydrangea, Azalea, Gardenia, and other plants requiring acid soils is an indication of lack of this acidity.

With the soil mixtures given in Table 1, plants will grow with little trouble from nutrient and moisture requirements. Since soils vary to a large degree in fertility, texture, structure, and water-holding capacity, it is impossible to follow the directions exactly. Where sandy soils are obtainable, the addition of more sand may be omitted; with a clay loam soil more sand and manure should be added.

Manure should be used only in the well-rotted stage. It is not considered mainly as a fertilizer, but as a soil conditioner. Well-rotted cow manure should be used in preference to other kinds. Manure loosens the heavier soils and acts as a source of favorable bacteria which are necessary for plant growth.

ENVIRONMENTAL GROUPING OF PLANTS

Potted plants are best grown in separate houses or in a condition where the environmental factors, such as temperature, humidity, and light are the same. If different plants are grown in the same house it is difficult to increase the temperature or fumigate without injuring the other plants. Poinsettias, followed with Lilies or Hydrangeas, and then bedding plants, will keep the space filled the entire season. Saintpaulia, Gloxinia, and tuberous-rooted Begonias do well under similar conditions. Lilies are easier handled if grown away from other crops. Roses and Hydrangeas may be grown successfully in the same house. Cyclamen and Poinsettias require separate houses.

SOIL STERILIZATION

Soil sterilization is necessary to control diseases caused by fungi, bacteria, and nematodes which live in the soil. Also, steam soil sterilization changes the structure of the soil. Several methods of sterilizing soils are in general use, and the individual grower must choose the one most adaptable to his particular needs.

STEAM

The most effective soil sterilizing agency is steam, and whenever facilities are available, the steam method should be used. A permanent box strong and large enough to hold a fair amount of soil is desirable. The length of time required for thorough sterilization depends upon the pressure of the steam, the moisture content of the soil, and the volume to be treated. Soils should be medium moist, never too dry or too wet. The soil temperature should reach 200° to 212° F. and stay there ½ hour. A measure frequently used is a potato placed in the coolest part of the soil; when the potato is baked, the sterilizing is complete. Steam sterilization will increase the soluble salts of soil previously used for greenhouse crops, and the soil should be leached with cold water before it is used.

BAKING

Small lots of soils in pots or flats may be effectively treated by baking in an oven. The baking should continue long enough to bake a moderate-sized potato placed in the center of the soil mass.

ELECTRICITY

Sterilization of soil by electric heat is undergoing considerable investigation in several parts of the country. Two general types of box sterilizers may be used: the heating element type, in which the heating elements are enclosed in metal sheets, and the resistance type, in which the current is passed through the soil and galvanized sheets are used as electrodes. Sterilizing boxes may be purchased from commercial concerns or constructed according to plans furnished by the Rural Electrification Division, Ohio State University, or by local power companies.

TABLE 1.—Soils and Fertilizers

Name	Soil reaction	Soil mixture	Fertilizer requirements*	Remarks
Astilbe	Neutral pH 6.8–7.2	3 parts silt loam 1 part manure	4-in. pot of 4–12–4 per wheelbarrow of soil, ammonium sulfate every 2 weeks after flower spikes appear	Requires large amount of water
Azalea	Strongly acid pH 4.5–5.5	2 parts silt loam 1 part imported peat	Light applications of ammonium sulfate before color shows will increase the size of flower.	
Begonia melior	Neutral pH 6.8–7.2	3 parts silt loam 2 parts manure 1 part imported peat 1 part sand	4-in. pot of horn shavings and 4-in. pot of 4–12–4 to wheelbarrow of soil	Do not use sand when basic soil is sandy. Do not use peat in acid soils.
Bulbs	Indifferent	3 parts silt loam 1 part sand		Very little fertilizer required if started with a normal compost soil
Calceolaria	Slightly acid pH 6.0–7.0	3 parts silt loam 2 parts manure 1 part sand	4-in. pot of 4–12–4 to wheelbarrow of soil	Use very little peat on the young plants.
Camellia	Strongly acid pH 4.0–5.5	2 parts sandy loam 1 part manure 1 part imported peat	5-in. pot of fertilizer made of: 5 parts cottonseed meal 3 parts superphosphate 2 parts potassium sulfate, to each wheelbarrow of soil	Do not have soil too rich in nitrogen.
Chrysanthemum	Slightly acid pH 6.0–7.0	3 parts silt loam 1 part manure 1 part peat	5-in. pot of superphosphate, 4-in. pot of horn shavings, and 4-in. pot of 4–12–4 per wheelbarrow of soil; ammonium sulfate every 2 weeks after final shift	
Cineraria	Slightly acid pH 6.0–7.0	3 parts silt loam 1 part manure 1 part sand	4-in. pot of 4–12–4 per wheelbarrow of soil, ammonium sulfate every 2 weeks after final shift	Additions of peat have not proved beneficial.
Cyclamen	Slightly acid pH 6.0–7.0	Light soil in young stages, later, 3 parts silt loam 1 part manure ½ part imported peat ½ part sand	4-in. pot of horn shavings, 4-in. pot of 4–12–4 per wheelbarrow of soil, ammonium sulfate every 2 weeks after final shift	
Cytisus	Neutral pH 7.0	3 parts silt loam 1 part manure	4-in. pot of 4–12–4 per wheelbarrow of soil. 15–30–15, 1 oz. to 2 gal. of water after plant becomes established	
Gardenia	Moderately acid pH 5.5–6.5	2 parts silt loam 1 part imported peat ½ part manure	4-in. pot of 4–12–4, 3-in. pot of ferrous sulfate per wheelbarrow of soil; regular applications of ammonium sulfate every 2 weeks plus ferrous sulfate, 4 oz. to 5 gal. of water	

TABLE 1.—Soils and Fertilizers—Continued

Name	Soil reaction	Soil mixture	Fertilizer requirements*	Remarks
Geranium	Neutral pH 6.5–7.6	4 parts silt loam ½ part manure	5-in. pot of superphosphate, 4-in. pot of 2–10–10 per wheelbarrow of soil	
Gloxinia	Moderately acid pH 5.5–6.5	3 parts silt loam 1 part manure 1 part peat or leaf mold 1 part sand		Grown under heavy shade
Hydrangea	Moderately acid pH 5.5–6.5	3 parts silt loam 1 part manure 1 part peat 1 part sand	5-in. pot of superphosphate, 4-in. pot of 4–12–4, 3-in. pot of aluminum sulfate to wheelbarrow of soil, provided the soil is neutral	1 lb. of aluminum sulfate to 5 gal. of water applied weekly from four to seven times during growing season if blue color is desired
Kalanchoe	Indifferent	4 parts silt loam 1 part manure	This plant does not respond to fertilizer treatment if a good compost soil is used in the mixture.	
Lilies	Slightly acid pH 6.0–7.0	4 parts silt loam 1 part manure 1 part sand	Ammonium sulfate every 2 weeks after plants are large enough	High phosphate will reduce height
Pelargonium	Slightly acid pH 6.0–7.0	3 parts silt loam 1 part manure	4-in. pot of 4–12–4 per wheelbarrow of soil	
Poinsettia	Slightly acid pH 6.0–7.0	2 parts silt loam 1 part manure 1 part sand	4-in. pot of superphosphate per wheelbarrow of soil, liquid fertilizer every 2 weeks after flower forms	Does better in soil low in plant nutrients
Primula	Slightly acid pH 6.0–7.0	3 parts silt loam 2 parts manure 1 part sand	4-in. pot of 4–12–4 per wheelbarrow of soil	No peat
Rose	Slightly acid pH 6.0–7.0	3 parts silt loam 1 part manure	4-in. pot of 4–12–4 per wheelbarrow of soil	
Saintpaulia	Slightly acid pH 6.0–7.0	3 parts silt loam 1 part manure 1 part peat 1 part sand	4-in. pot of 4–12–4 per wheelbarrow of soil in final shift	Do not overshift or overwater. Grow under heavy shade during summer.
Yellow Calla	Slightly acid pH 6.0–7.0	3 parts silt loam ½ part manure ½ part sand	Ammonium sulfate every 2 weeks after plant becomes established	

*The term wheelbarrow refers to a barrow containing approximately 2½ bushels of material.

HOT WATER

Soils for flats and pots can be fairly well sterilized by drenching with hot water (212° F.). Enough boiling water should be added to saturate the soil completely. This treatment is effective in killing nematodes, as well as fungi and bacteria. The objection is that some soils are badly puddled and put in such a physical condition that it is difficult to work them afterwards. Propagating sand and benches are easily sterilized with two drenchings of boiling water.

FORMALDEHYDE DRENCH

Chemical sterilization is effective and may be used where steam is not available. The soil is saturated with a solution made by diluting 1 gallon of commercial formalin with 50 gallons of water. After the treatment the soil should be covered with paper or canvas for 24 hours and then put in a warm place to dry. As long as an odor of formaldehyde can be detected in the soil it is not safe to plant. Usually 10 days to 2 weeks should elapse between the time of treatment and planting.

FORMALDEHYDE DUST

Damping-off of seedlings and cuttings may be prevented with the use of 6 per cent formaldehyde dust. Six ounces of commercial formaldehyde dust are mixed with each cubic foot of soil by shoveling it over several times. The soil is placed in pots or flats and the seeds may be sown at once if desired. If weak or low-vitality seeds are used they should not be planted until 24 hours after treating the soil. Three to 4 days should elapse before the soil is used for potting rooted cuttings.

SANITATION

The practice of removing all possible breeding places for disease and insects should be adhered to strictly. Close observation should detect the sick plants, and greenhouses should be kept clean.

CULTURE OF MAJOR POTTED PLANTS

ASTILBE JAPONICA

The Astilbe is readily propagated by dividing the clumps in the spring and growing them in the field until after frost. Then they should be lifted and potted in 5- to 8-inch pots in a porous, fertile soil. From 10 to 14 weeks is required to bring them into flower in temperatures of 55° to 60° F. Gladstone will flower in a shorter time than the newer varieties.

If clumps arrive before they are to be potted, they should be placed in flats with moss or soil between the clumps. The flats may be set outdoors or in a protected frame. Light frosts are beneficial in breaking the dormancy of the plant.

Abundance of water is essential, especially when the flower sprays begin to develop the first of March. Weekly applications of liquid urea, ammonium sulfate, or liquid manure are very desirable. Fumigation with tobacco or cyanide may cause injury to foliage and should be avoided.

Astilbe will flower earlier if the clumps are immersed in hot water at 110° F. for 1 hour in October, stored until early January, and then potted and started. With the use of this treatment plants can be obtained by February.

The varieties grown are Gladstone and Avalanche, in white; Philadelphia, Queen Alexandra, Peachblossom, Princess Mary, and Rubens in pink.

AZALEA

Azaleas of all types are increasing in popularity, both for forcing under glass and for outdoor planting. Many of the large-flowered Belgian forcing types which have been excluded from the United States since 1916 by quarantine are to be had in quantity again. With the successful propagations in California and the Atlantic Coast States, the range of varieties now available covers all the favorite kinds formerly imported.

Azalea indica, Azalea amoena, and the Kurume types are propagated by softwood cuttings in the winter and early spring in the greenhouse, or from outdoor plants in summer. A mixture of sand and peat is the best medium, and bottom heat is helpful. An alkaline sand should not be used, as Azaleas require an acid medium (pH 5.0). The same types are also grafted in February and March using *Azalea ledifolia* and ledifolia alba as understock. A grafting case with a temperature of 55° to 58° F. is necessary for the operation. It is advisable for the majority of growers to purchase stock ready for forcing rather than growing on the young stock. As soon as the plants arrive from the producer, unpack them carefully and immerse the earth ball of each plant in a bucket of water until the bubbles cease rising; then allow the plants to drain. Pot up promptly and firmly in a soil containing one-third to one-half acid peat. Do not add any materials, such as lime or bonemeal, which will make the soil alkaline. If the shipment arrives in very cold or zero weather, keep the cases in a cool room for at least 48 hours before unpacking. Then place the plants in a dark, cool place for a similar time after removing them from the case, meanwhile syringing the plants with cold water. This gradual thawing will remove the frost without injury to the buds.

After potting, place the plants in a cool greenhouse where the temperature is not above 45° F. at night for the first 2 or 3 weeks. Later, the temperature may be increased to 50° F., with an abundance of water at the roots and in the atmosphere.

Formerly, the deep-rose Mme. Petrick and the pink and white Petrick superba were the only two varieties which the average florist with ordinary facilities could force for Christmas. However, plants of Van der Cruysen, vervaeneana, and Prof. Walters secured from California will flower successfully for Christmas if flower buds are developed sufficiently when received. This condition of the buds is more likely to occur in plants 12 to 14 inches in diameter or larger than in the 8-inch to 10-inch crowns. The *A. rutherfordiana* is an innovation to the Azalea family. The flowers are single, semidouble, and double, and white to deep crimson, including orange, salmon, and all the other characteristic tones. This species will force easily for Christmas. The same varieties, together with Paul Schoen, Albert Elizabeth, Mrs. Fred Sanders, Jean Haerens, and Empress of India, can be forced successfully for Valentine's Day and Easter.

Forcing Azaleas for Christmas necessitates maintaining a temperature of 45° to 48° F. until November 5, when the plants should be brought into a 60° to 65° F. house. The varieties used for Valentine's Day should be started in a

warm house early in January. The exact temperature to be maintained will depend upon the amount of sunlight available. A temperature of 60° F. is safe, since if the buds develop too early, the plants may be retarded in a cool-house without detrimental effects.

For Easter flowering, Azaleas should be kept on the bench of a cool greenhouse with a night temperature as near 40° to 50° F. as possible until March. Then they can be subjected to heat according to weather conditions and the date upon which Easter falls.

The new growth that appears at the base of the flower buds in December and as spring approaches should be pinched out, and this should be continued until after the plants have bloomed. Neglect of this will result in small flowers and blind and blasted buds. Syringing with warm water is beneficial and will develop evenness of flowering.

Red spider and thrips are occasionally the cause of poor foliage and flowers. Insect attack during the growing season has been known to cause leaves to drop when forcing is started. Heating in transit will also cause loss of foliage.

If plants are unsold they should be trimmed back after Easter and placed in a light, moist, warm house to encourage new growth. In June the pots should be plunged up to the rim outdoors, or the plants should be planted directly in the soil and kept growing under partial shade until September, when they should be taken in and forced slowly for spring flowering.

The Kurume types of Azalea, comprising such varieties as Christmas Cheer, Coral Bells, Orange Beauty, Pink Pearl, Salmon Beauty, Snow, and hinodegeri, are supplanting the indica types because of cheapness, ease of forcing, and the possibility of flowering plants in small sizes to be sold in 3- and 4-inch pots.

Early propagated stock should make good 2-inch plants by early spring. If propagated or purchased, these small plants should be potted in soil composed of one-half acid domestic peat and one-half sandy loam soil. Alkaline sand is very detrimental to the Azalea. These young plants may be grown on during the summer in pots or frames, depending on the climatic conditions and soils. In early May the plants may be planted directly in cold frames in a mixture of peat and soil. The frames should be located to provide for perfect drainage. After May the sash should be removed and lath substituted until late in August. Such plants will grow large enough to be potted in 4-inch pots in September or early October. During the summer, clean culture is essential, and the plants should be examined regularly for red spider, thrips, and leaf miner. To maintain humidity, frequent syringing is desirable, particularly in the evening to simulate the effect of dew. All shaping should be done in the spring, and some pinching may be necessary (but not later than July) in order to develop ripened wood and a set of buds before fall. Yellowing of the foliage, or chlorosis, is the result of an alkaline soil or poor root development and shows the effect of lack of available iron. Ferrous sulfate, 4 ounces to 5 gallons of water, applied biweekly, will correct this abnormality.

Kurume Azaleas will force very similarly to other types. For Valentine's Day the plants should be placed in the heat in early January. For Easter, the plants should be grown in as cool a house as possible without freezing.

BEGONIA

For horticultural purposes, Begonias may be arranged in four groups: the socotrana or semituberous rooted; the tuberous rooted; the foliage, usually rhizotomous; and the fibrous rooted.

The semituberous group is of the greatest value to the florist, as it contains the Christmas-flowering varieties, such as Lady Mac, Melior, and Marjorie Gibbs. This group of Begonias is propagated in November and December by petiole cuttings from medium-sized, well-ripened leaves. The petioles are inserted in sand or one-third German peat and two-thirds sand with a bottom temperature of 70° F. and so spaced that they do not touch one another. The petiole should not be placed deeply enough to have the leaves come in contact with the sand. Rooting takes place in 4 to 5 weeks, but potting should be deferred until new shoots begin to develop from the base. In potting, it is necessary to place the crown of the cutting as near the surface as possible. A soil mixture which contains considerable sand, and peat moss or leaf mold should be used. The bottom temperature should be near 70° F. to insure proper growth. Plants in 2-inch pots are in the most critical stage and should be watched carefully.

To produce good plants for Christmas the plants should be in 4-inch pots in June and in 6- and 7-inch pots in September. For the later pottings a soil mixture of 3 parts of silt loam, 2 parts of manure, 1 part of peat, and 1 part of sand, plus a 4-inch pot of horn shavings and a 4-inch pot of 4-12-4 fertilizer per wheelbarrow of soil, has given very good results. Late shifting in October will produce weak plants with insufficient root action.

During the summer, humid atmosphere and partial shade are desirable. Pinching is necessary to secure stocky plants. The toppings root readily and will produce good 2½- or 3-inch plants suitable for combinations by Christmas. Biweekly applications of 1 ounce of 15-30-15 fertilizer to 2 gallons of water are advisable. Staking is necessary, since the stems are very brittle. Night temperatures of 58° to 60° F. are most satisfactory and will bring the plants into full bloom in December. The finishing temperature should be 56° F., being dropped to that 2 weeks before Christmas to harden the plants and secure a deeper color. Marjorie Gibbs, Melior, and Lady Mac are the better varieties of this type of Begonia.

Another new group, Holland Begonia, is a cross between the socotrana and the tuberous-rooted groups. Cuttings should be taken from the new shoots which are produced in May or June or from petiole or leaf cuttings taken in November and December. This group has single and double flowers and is earlier than the regular Melior, flowering in November. Their dormant state is from January 15 to April. Water should be used sparingly during this period, but the temperature should be maintained at 60° F. The better varieties are Pink Perfection, Augustine, Baardse's Favorite, Baardse's Orange, Baardse's Red, Elatior, Dix, and Mensing.

Tuberous-rooted Begonias are entirely deciduous. They make fine bedding plants, as well as splendid greenhouse pot plants, from June to September. As a house plant they are not recommended because they soon drop their showy petals. Propagation is by seed, which is sown in January in a compost of peat, rotted wood, and leaf mold. The seed of all Begonias is very minute and no covering of the seed with soil should be attempted. The soil in the pan is watered well, and then the seed is sown on the surface. The pan is covered

with a pane of glass till the seed germinates. When the seedlings are large enough to handle, they are pricked off into flats. They are kept on a well-lighted shelf, and when grown so that they are nearly touching, put into 2½-inch pots. These seedlings will make 3-inch plants by June, and are more satisfactory if carried over for the second season. In the fall, the plants are gradually ripened off; the water is reduced; and finally the pots are placed on their sides under a bench in a house with a temperature of 40° F. In March and April the tubers should be removed from pots, cleaned of old roots, started anew in flats, and later potted.

To the fibrous-rooted group belong *B. semperflorens* and its varieties, such as Vernon, Gloire de Chatelaine, Bonfire, Prima Donna, Luminosa, Mrs. Patten, Pride of Newcastle, Gustav Lind, and Westport Beauty, as well as hybrids like carrieri and erfordi. These are propagated by seed or stem cuttings. Division is also practiced with such varieties as Chatelaine. A coarse but fibrous soil, with additions of peat, makes a satisfactory medium for potting. Seed should be sown in fall and early winter to produce a good-sized plant in May or June. A temperature of 52° F. is satisfactory.

Begonias are troubled with red spider, mites, thrips, aphids, and mealy bugs. Regular weekly spraying should be followed. The leaf nematode of Begonia, commonly known as the eelworm or nematode trouble, causes a condition often spoken of as rust. It is a serious problem on the semituberous group and occasionally, on the fibrous-rooted Begonias. The symptoms first become apparent upon *B. melior* and similar varieties as small brown spots with a water-soaked margin on the under sides of the leaves. These spots increase in size, then merge if there are several on the leaf, and become dark brown in color. The discoloration soon becomes visible from the upper surface, and a brown blotch is formed covering the entire leaf. Affected plants are definitely stunted.

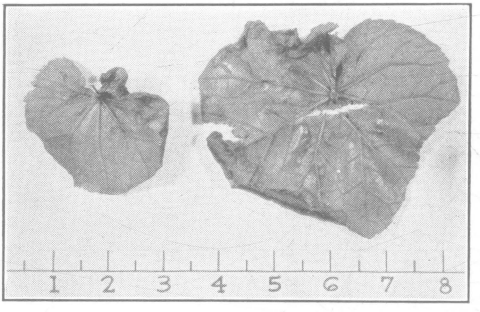

Fig. 1.—Foliar nematode injury on Melior Begonia leaves

Within the leaves are found large numbers of the microscopic, wormlike nematodes. The eelworms rupture the cell walls by their movements and by actual piercing. They emerge from the leaf when moisture is present and move from part to part. Syringing the plant will hasten the spread. Infection occurs through the stoma.

No spray will control the nematodes without decidedly harming the plants. Healthy leaves should be used for propagation. Soil infested with nematodes through discarded diseased leaves or plants should not be used. Adequate

space should be provided so that the leaves of neighboring plants do not touch. Infested plants should be isolated, and leaves showing the disease should be removed and destroyed as soon as found. Care should be taken not to wet the foliage.

Verticillium wilt disease has been troubling the semituberous group. This trouble produces leaves which are shiny underneath and much thinner than the normal leaf. In young plants the entire plant is affected, but in older plants often only one or two shoots show this trouble. Roguing the diseased plants is the only known cure.

BULBS

HYACINTH

Hyacinth bulbs are usually received in September or early October. The term prepared indicates that the bulbs have been subjected to special heat treatments. Prepared bulbs may be had in flower in December.

The usual time for potting is in September or October. The soil used should be well drained, porous, and only fairly fertile. Top-size bulbs (2¼ to 2⅝ inches in diameter) may be placed in pots as follows: one in a 4-inch pot; 3 in a 5-inch pot; 4 in a 6-inch pan; and 5 in a 7-inch pan.

The bulbs should be placed close together, with the tips about ½ inch below the rim of the pot, and the soil should be firmed about them. The next process, after thorough watering, consists of placing the pots in cold frames or directly outdoors, where they are covered with a thin layer of sand, then with soil, and finally, with straw. The depth of the covering should be 8 to 12 inches, depending upon the latitude of the grower's location.

In place of such treatment, many growers utilize cold storage facilities in which bulbs are placed in artificially refrigerated buildings on shelves surfaced with peat to retain moisture. Temperatures of 45° to 50° F. are maintained under such conditions. Cool temperatures are necessary for root development.

For Christmas forcing, the prepared Hyacinths may be brought from the outside or from under the benches in a coolhouse between November 25 and December 1 and placed in temperatures of 75° to 80° F. with an abundance of moisture. The hot box used for forcing may be constructed of canvas frames placed over benches with adequate heating surface. The box is kept hot, moist, and dark. Under such conditions the foliage is drawn up and lacks green color. At the same time the flower stem becomes elongated and well developed. Before the plants are sold they should be placed in a greenhouse, given light gradually to regain color, and hardened in a temperature of 50° F.

After January, Hyacinths may be forced into flower 2 weeks after being brought from cold storage, although it is best to bring the plants in 3 to 4 weeks before they are wanted. With a bulb cellar no difficulties are experienced in bringing the plants in for a specified time. There is little danger from breaking of tips and damage to flower stems if the pots are left out in the cold for too long a period. Failure to develop, with the outward appearance of the flower stem's having been cut off or popping, is due to a number of things; chilling while being transported from outdoor beds to the greenhouse, improper curing and storage of the bulb, and too rapid forcing are the chief causes.

The varieties which produce large, heavy spikes need staking. Green sticks may be inserted into the bulbs and the stem may be tied to these with green twine.

The dates for starting Hyacinths are:

January 1—L'Innocence, Nimrod, Bismarck, and Dr. Leiber
January 15—Gertrude, Lady Derby, Schotel, Grand Maitre, Gen. de Wet, Prince Henry, and La Victoire
February 1—Marconi, City of Haarlem, Myosotis, and Westminister
February 15—Queen of the Pinks, Queen of the Whites, Queen of the Blues, King of the Blues, and La Grandesse

LILY

A number of species are used in forcing. The most common are *Lilium longiflorum*, its varieties, giganteum, erabu, multiflorum, formosum, harrissi, and several selected strains of giganteum. *Lilium longiflorum giganteum* and erabu are used to the largest extent as pot plants for Easter.

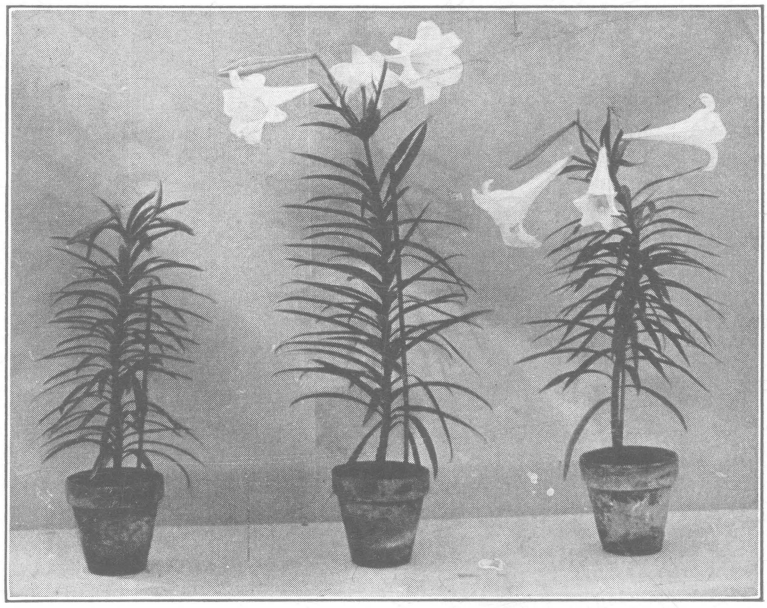

Fig. 2.—*Lilium longiflorum*. The effect of additional heat versus additional light. Left—Check at 60° F. Center—60° F. and 4 hours of additional illumination. Right—72° F., no illumination

Lilium longiflorum giganteum should be potted from November 20 to January 1, depending upon the Easter date. Heavy, yet porous, slightly acid soil is ideal as a potting compost. Seven- to 9-inch bulbs are the most practical to use, although for a large number of flowers per stem the 8- to 10-inch size may be substituted. Northern-grown bulbs are preferred over Southern-grown ones. Northern-grown bulbs produce shorter plants with more blooms on a plant than Southern-grown bulbs. In potting, the individual bulbs should be set deep in 5- or 6-inch pots and placed on the bench in a temperature of 54° to 56° F. Too many lilies are ruined by starting in too cool a temperature. The plants should be started with a dry soil; as the roots begin to appear the moisture content should be increased.

After the roots have started, the temperature of the house is gradually increased to 60° F., or above if necessary. Under such conditions 13 weeks are necessary for flowering. After the buds show, 5 to 6 weeks are usually required.

Supplementary illumination.—The use of supplementary illumination to prolong the length of day is of value on backward lilies. A number of lilies were placed under 6 hours of additional illumination from 6 P. M., beginning February 18, with a temperature of 60° F. at night, and 10 degrees higher during the day. A similar number was placed in a temperature which averaged 72° F. at night and 90° F. during the day. A third lot was grown at a temperature of 60° F. at night and 10 degrees higher during the day. Six 150-watt lamps, each consuming 120 watts (owing to voltage drop), were placed over 150 lily plants. The lamps were suspended 18 inches above the plants.

TABLE 2.—The Effects of Supplementary Illumination on *Lilium longiflorum giganteum*

Treatment	Average stem length	Average flowers per bulb	Date of flowering
	In.	*No.*	
Additional heat, 72° F.	14.3	3.1	March 25
Six hours of additional light, 60° F.	19.3	3.1	March 26
Check, 60° F.	16.3	3.6	April 10

Additional heat resulted in shorter-stemmed plants than the other two treatments. The date of flowering as the result of additional heat was very close to that of the plot which received additional light, with a 1-day difference in favor of the higher temperature. The cost of additional illumination was 3.1 cents per pot.

Since both the additional light and the higher temperature produced similar results, the choice of method will depend upon the difference in price and the availability of equipment. Supplementary illumination should be applied at least 2 months before the date the flowering plants are needed.

It must be borne in mind that with extremely high temperatures, blasting of buds will occur unless frequent syringing is used to maintain proportional humidity. Splitting of flowers may be caused by too rapid a change in temperature, insufficient root action, bulb mite, or improper curing and storage of bulbs.

The effect of phosphorus on flowering.—To determine the effect of phosphorus on the length of stem of the lily, a series of plots was tried in 1935-1936 and 1936-1937. Sand, sand and peat, and soil were used. Howlett's modification of Shives' nutrient solution was used throughout the test on the sand and sand and peat plots. Superphosphate was used on soil low in phosphorus until a high test reading for phosphates was obtained by using the Spurway soil test for phosphates. Monobasic sodium phosphate ($NaH_2PO_4.H_2O$) was used in liquid form.

Table 3 shows that high available phosphate retarded the stem elongation in all plots except the sand and peat used in the 1935-1936 test.

After the lilies begin growing it is advisable to place the shorter plants toward the center of the bench. This will produce lilies more uniform in height.

TABLE 3.—Effects of Low and High Phosphorus on *Lilium longiflorum giganteum*

1935-1936 results

	Number of bulbs	Number of flower stems	Average height	Average number of flowers per stem
			In.	
Wooden tubs, 6½-in. (2 bulbs to tub)				
High P soil	20	7	10.7	2.0
Low P soil	20	20	16.5	3.3
Clay pots, 5-in. (2 bulbs to pot)				
High P soil	20	10	12.0	2.6
Low P soil	20	20	14.8	2.8
Clay pots, 5-in.				
High P soil	15	6	12.5	2.5
Low P soil	15	14	16.0	3.2
Clay pots, 4-in.				
High P soil	20	15	12.2	2.0
Low P soil	20	22	17.0	2.9
Sand—5-in. pots				
Complete solution	20	21	18.1	3.4
Minus P solution	20	21	20.2	3.7
Sand and peat—5-in. pots				
Complete solution	20	24	16.9	2.5
Minus P solution	20	21	15.1	2.7
Superphosphate	20	23	15.2	2.79

1936-1937 results

Treatment	Number of plants	Number of stems	Average height	Average number of flowers
			In.	
Lilium l. giganteum, $NaH_2PO_4.H_2O$, 1 oz. to 1 gal. biweekly	34	38	19.4	3.5
Lilium l. giganteum, $NaH_2PO_4.H_2O$, 1 oz. to 2 gal. biweekly	32	40	23.1	3.9
Lilium l. giganteum, $NaH_2PO_4.H_2O$, 1 oz. to 2 gal. weekly	32	37	22.1	4.1
Lilium l. giganteum, $NaH_2PO_4.H_2O$, 1 oz. to 1 gal. weekly	32	41	20.5	4.1
Lilium l. giganteum, check	32	38	23.2	3.1
Lilium l. erabu, 4-in. pot of superphosphate to 1 bu. of soil. 12/1/36	37	40	15.5	3.3
Lilium l. erabu, 3-in. pot of superphosphate to 1 bu. of soil	38	40	17.0	4.3
Lilium l. erabu, 2-in. pot of superphosphate to 1 bu. of soil	36	42	20.7	4.2
Lilium l. erabu. Check. Soil low in P.	39	43	26.8	4.5
Lilium l. erabu, 1-in. pot of superphosphate to 1 bu. of soil	39	43	23.3	4.2

Fertilization is best accomplished by using liquid nitrogenous applications, such as ammonium sulfate, urea, nitrate of soda, or nitrophoska, at biweekly intervals after tops are 6 inches or more above the pots. Water warmed to 70° F. is more satisfactory than cold water.

Lilium longiflorum giganteum erabu cannot be forced as quickly as the giganteum. Eight weeks in a cold house are required to develop a good root system; then in a temperature of 55° F., 3 months will be required for blooming.

Lilium longiflorum formosum is handled similarly to giganteum, but should be forced in smaller pots and grown in a moderately moist soil.

Brown tips on lily leaves are the result of a check in growth or tobacco spraying or fumigation. The most troublesome diseases of the lily are mosaic and yellow flat. Both are virus diseases and the only prevention is to rogue the affected plants. Bulb mites and aphids are the most troublesome pests. Dipping the bulbs for ½ hour in a 1-400 solution of nicotine sulfate before planting will give partial control of the mites.

NARCISSUS

Narcissus pseudonarcissus, *N. incomparabilis*, and *N. barri* make ideal potted plants which are easily grown. A fibrous, medium heavy loam is a satisfactory medium for potting. Three-quarter–size pots should be used, and the bulbs should be placed as closely together as possible; thus, a 6-inch pot will hold from three to six bulbs, depending on the size and the variety. Double-nose bulbs are usually preferred.

After potting and watering, the plants are set outdoors on level ground and covered with a layer of sand and then a layer of soil similar to that described for hyacinths. After the bulbs have made sufficient root growth, usually in January, the pots should be brought into a 45° F. temperature for several days, then into 50° to 55° F. temperatures. After the buds become free from the bulb, higher temperatures may be given, but excess of 60° F. at night is not advisable. Usually 3 to 4 weeks are required to flower King Alfreds in January and early February; the time will be shortened somewhat later in the season. To secure length of stem the plants should be placed in darkness, under a bench or in a cellar, and brought to light about 1 week before flowering to insure greening of the foliage.

For Christmas bloom, the bulbs of early dug varieties are placed in storage at a temperature of 50° F. August 15, potted about the middle of September, and left in the same storage or placed in a heeling-in ground until the roots have grown sufficiently, usually about November 15. From then on the plants are grown in the greenhouse similarly to others mentioned previously. King Alfred, in particular, responds to this treatment.

Narcissus is troubled occasionally with root rot, mites, streak, and the nematode disease.

TULIP

Tulips are planted in the early fall in soil which has a good structure, preferably free of manure. The first leaf of the plant will develop on the side of the stem which corresponds to the flat side of the bulb. Some growers prefer to have the leaves droop over the pot; this requires planting the flat side of the bulb facing the rim of the pot.

Single Early Tulips are planted as follows: six bulbs to a 5-inch pan; nine bulbs to a 6-inch pan; and 12 bulbs to a 7-inch pan.

Doubles and Darwins are planted: six bulbs to a 6-inch pan; eight bulbs to a 7-inch pan; and 11 bulbs to an 8-inch pan.

After potting, the pans should be stored outdoors in a heeling-in place or in cold storage similarly to Hyacinths and Narcissi. Early Single will flower in 4 weeks if brought into a 55° F. house for 10 days and then raised to 65° F. Darwins and Doubles require from 4 to 6 weeks, depending on temperatures and variety. Precooling may be used with Darwins, Triumphs, and Mendels as with Narcissi.

The time to start forcing the different varieties of Early Single Tulips is as follows:

December 20—Brilliant Star, King of the Yellows, Proserpine, and Rose Precose

January 1—Fred Moore, Prosperity, Rose la Reine, Vermilion Brilliant, Lady Moore, and Duc de Berlin

January 15—Cullinan. Flamingo, Ibis, Prince of Austria, White Hawk, Yellow Prince, and General de Wet

February 1—Hobbema and Pink Perfection

February 15—Couleur Cardinal, Rose Luisante, and Jonkoping

Forcing Early Doubles should start:

January 1—Couronne d'or, El Toreador, and Tournesoll

January 15—Mr. van Tubergen and Orange Globe

February 1—Electra, Mr. van der Hoeff, Murillo, Peach Blossom, Schoonoord, Tearose, and Marechal Neil

Darwin varieties should not be brought in before the following dates:

December 15—Wm. Copeland and Allard Pierson

January 1—Lenotre and Wm. Pitt

January 15—Centenaire, Prof. Rauwenhoff, and Victoire d'Oliviera

February 1—Bartigon, Farncombe Sanders, Sieraad V. Flora, Vir. Verbrugge, and Santa Rosa

February 15—Ant. Roosen, Mad. Krelage, Princess Elizabeth, King Harold, Herodiade, and Matchless

Triumph varieties can be started into forcing the following dates:

January 1—Crown Imperial

January 15—Denbola, Elisabeth Evers, Kansas, Ursa Minor, Alberio, Telescopium, and Virgo

February 1—Aviateur, Castor, Edith Eddy, Ellinosa, Mississippi, Queen Victoria, Tosca, Wellington, Wisconsin, and Zimmerman

Botrytis blight or fire is the most common disease of tulips. Minute, yellowish spots surrounded by a water-soaked area appear on the leaves and flower stalks. A gray fungous growth can be seen in the center of these areas during very humid periods. To prevent this disease the bulbs should be sorted carefully before planting and the outer husks should be removed. All bulbs with resting spores or rot lesions should be discarded. If the disease appears at the time of forcing, the humidity should be reduced, and the ventilation, increased.

Nematode infestation is evidenced by browning and dying of root tips without the usual swellings.

CALCEOLARIA

There are two distinct types of Calceolarias, namely, hybrida and integrifolia, the former herbaceous, the latter shrubby. Both are showy plants suitable for Easter and Mother's Day. *Calceolaria hybrida* is propagated by seeds sown in July and August. Great care should be used at this stage. The soil used in germinating the seeds should be rather light and made up of equal parts of soil, sand, and well-rotted manure.

This soil should be sterilized, preferably with steam, for 2 hours. The seeds should be sprinkled evenly over the surface, covered lightly, then watered with a fine spray. A heavily shaded house is best suited for germination. Growers should be on the watch for camel crickets and sow bugs, as they destroy an entire flat of seedlings within a short time.

When the seedlings are large enough to handle, they should be pricked off into other flats. Care should be taken not to overwater, to keep them away from drafts, and to keep a heavy shade over the young plants for best results, as extreme heat is detrimental to Calceolarias. From flats the young plants are shifted to 2½-inch pots. By early December the plants should be in 3-inch or 3½-inch pots. The final shift should be made in January if the plants are to be in flower for Easter.

The soil used should be slightly acid. A good soil mixture consists of three parts of loam, two parts of well-rotted cow manure, and one part of sand. A 4-inch potful of a 4-12-4 fertilizer is added to each wheelbarrow of this mixture for the final shift. Yellowing of the foliage may be due to overwatering, too acid or too alkaline soil, or a lack of nitrogen. Oftentimes Calceolarias are overpotted, and it is always well to remember that when any plants are shifted the watering should be watched until new roots are visible. A temperature of 50° to 55° F. is satisfactory.

During the past few years many new varieties have been developed. The most outstanding is multiflora nana. This plant is short in habit of growth; the individual flowers are medium in size; and the colors are brilliant. Albert Kent Hybrids, Kelway's Perfect Model, and grandiflora nana tigrina are all worthy of a trial.

The shrubby varieties, such as Stewarti, Pink Beauty, Talisman, Rosacker's Brilliance, and Theodore Wirth, are propagated by cuttings. The stock plants should be selected in March of the previous year and never allowed to flower. Stock plants should be kept in the coolest house available, as the summer heat is destructive. It is practically useless to try to carry stock plants over in localities where summer heat is intense. Cuttings should be ready to take in August. These cuttings will root within a month and should be potted into soil similar to that used for *C. hybrida.* To prevent the toppling over of stems, deep potting at each shift is necessary.

The flower spike requires some support; using No. 22 copper wire hooks instead of string develops a better plant. The wire hook method is a much faster means of supporting the plants, and a few growers have used it and found it successful. The wire is hooked about the stem and inserted into the soil as close as possible to it.

SUPPLEMENTARY LIGHT

Calceolarias respond in earliness of flowering to the use of supplementary artificial light. A test was conducted to determine the most economic intensity for securing the desired results. On December 20, 1933, six plots with 20 plants of multiflora nana to a plot were arranged under supplementary illumination with two Mazda lamps for each plot. The additional light was given from 5 P. M. until 10 P. M. each day. The plots tested were illuminated as follows: Plot 1, 25-watt lamps; Plot 2, 40-watt lamps; Plot 3, 75-watt lamps; Plot 4, 100-watt lamps; Plot 5, 150-watt lamps; and Plot 6, check.

On February 13 flower spikes became visible in all lighted plots. On February 26 all lighted plots showed color and the plants were fully matured by March 10. The check plot flowered April 7.

Light applied January 17 for 4 hours each night produced Calceolaria plants in full flower March 28 when the temperature was maintained at 50° F.

Calceolaria Rosacker's Brilliance was supplied with additional light from 100-watt lamps (5 to 10 P. M.), beginning November 17, in an attempt to produce flowering specimens for Valentine's Day sales. The application continued until February 1, and February 15, the plants were in full bloom; checks flowered May 10.

Neon light.—Roodenburg (6), working with additional illumination, found that neon lamps were more efficient than the universally used Mazda lamps.

The purpose of this test was to determine whether or not neon or mercury-vapor lamps were more efficient in shortening the period of bloom of Calceolaria than Mazda lamps.

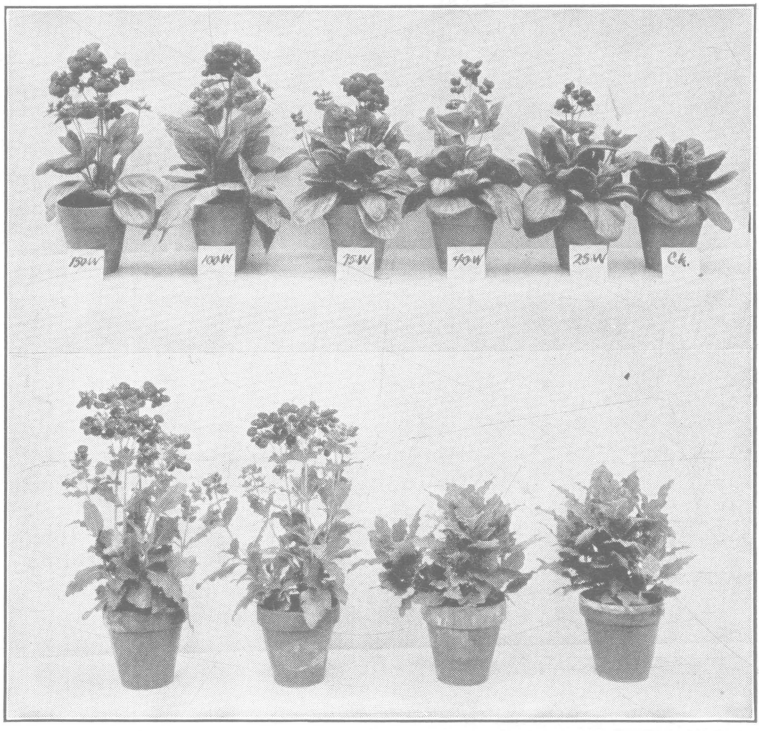

Fig. 3.—Top—*Calceolaria multiflora nana*. Effect of additional illumination on maturity. Left to right—150-watt, 100-watt, 75-watt, 40-watt, and 25-watt lamps, and check. Bottom—Calceolaria Rosacker's Brilliance. Left two plants received 5 hours of additional supplementary light (5 to 10 P. M.) from 100-watt lamps, November 17 to February 1. Photographed February 17

Four plots with 10 plants of *Calceolaria multiflora nana* in 5-inch pots were used. Plot 1 was the check. In Plot 2, two 225-watt, clear glass lamps were used. Plot 3 had a neon, 450-watt lamp, and Plot 4, a mercury-vapor, 450-watt lamp.

The lamps were hung 3 feet above the pots, directly over the center of the bench. Drop curtains separated the plots. The lights were started at 5:30 P. M. and allowed to burn until 9:30 P. M.

Calceolaria plants were placed under the lamps December 19, 1934.

TABLE 4.—The Effect of Supplementary Light from Mazda, Neon, and Mercury Lamps upon the Time of Flowering of the *Calceolaria hybrida nana*

	Date	Days earlier than check
Mazda	March 7, 1935	38
Neon	March 25, 1935	20
Mercury	March 30, 1935	15
Check	April 14, 1935	.....

The results in Table 4 show that plants grown under Mazda lamps flowered 18 days earlier than those under neon and 23 days earlier than those under mercury. The results of this test indicate that Mazda lamps are superior to either neon or mercury in producing earliness of bloom, greater flower development, and general growth of plants.

TEMPERATURE

Temperature variation tests were conducted in November, 1933. Two plots were set up, one at a night temperature of 60° F., the other at a temperature of 50° F. Supplementary light was applied to half the plots in both temperatures, November 17. The warm plots did not produce any flower buds; whereas with the 50° F. temperature, Calceolarias flowered February 15 and May 10. The former plot received additional light. High temperatures, regardless of day length, controlled the bud formation.

Fig. 4.—Effect of potassium on the growth of *Calceolaria hybrida* (soil pH 6.2). Left to right—high potassium; potassium-deficient plant to which potassium chloride was applied 11 days before picture was taken; potassium deficiency.

Another test to study the effects of high temperatures after buds formed was started March 4. Seedling plants of the Rosacker's Brilliance type were used. The plants received supplementary light and were showing color March 4. At that date half were placed in a 60° F. house.

The results showed that additional light plus a warmer temperature produced slightly earlier blooming. However, plants grown in the 50° F. house were the better plants. They were more stocky, and had more flowers with much stiffer stems. For the small difference in time of flowering it is advisable to finish in a cooler temperature.

Thrips, green aphids, stem rot, and chlorosis are troublesome on Calceolaria.

CAMELLIA

Between 1835 and 1860 *Camellia japonica* was grown extensively in greenhouses in the colder regions of the United States and was considered one of the most popular flowers grown in the greenhouse. Camellias are becoming more popular, and are being used as cut flowers and potted plants. Plants grown in pots produce very showy flowers over a period of several weeks during winter.

Camellias may be propagated by seeds, cuttings, grafting, and layering; however, propagation by cuttings is the method employed almost entirely. Cuttings of mature wood of the current season's growth should be taken between August 15 and February 15 and placed in a closed case with a bottom temperature of 72° F. Sand or sand and peat have given good results. A period of from 80 to 100 days is required for rooting; then the cuttings are potted in a mixture of two parts of sandy loam, one part of well-rotted manure, and one part of acid peat. The soil must be acid for best results. Plants should be at least 6 years old to produce a commercial crop the first season. Plants dug from the field seldom produce flowers the first year. It usually takes 2 years to get field-grown plants established in tubs before flower production can be hoped for.

The care of the plants after they reach flowering size is very important. Camellias are found growing natively in China and Japan under partial shade, with uniform moisture, high relative humidity, good drainage, an even unfluctuating temperature, and plenty of ventilation, winter and summer.

From November until flowering, a day temperature of 42° to 45° F. is best and is necessary to produce firm-textured petals with good keeping qualities. Night temperatures should be between 34° and 42° F. If such temperatures cannot be maintained, the temperature may be raised slightly, but not higher than 50° F. during the day. Immediately after flowering, the night temperature should be increased to 55° to 65° F. to stimulate new wood and leaf growth.

Repotting should be done every year immediately after the plants finish flowering and before any new growth starts. Repotting in September will not prove satisfactory unless the plants can be carried sufficiently cool to prevent the development of new wood. New growth, so made, is not likely to produce flower buds. Wooden tubs are better than porous pots, and sufficient drainage is essential. If porous pots are used, plunging these pots into peat, sphagnum, or any other moisture-holding material is advocated to prevent drying out. It is very important that the fresh soil be packed tightly against the original ball of roots to avoid air spaces. Immediately after potting, the soil should be saturated with water. Although Camellias thrive in uniformly moist soil, they are not aquatics and will not tolerate wet feet.

A good potting soil may consist of fibrous sod with one-fourth acid peat and sufficient coarse sand to insure drainage and aeration. Acidity of the soil is important and should be kept at a pH of between 4 and 5. In neutral or alkaline soils the growth will be short; the foliage, yellow-green; and the roots will fail to develop. Frequently under such conditions the tips of leaves will turn brown and the under side of the foliage will appear scaly as if infected

with fungous trouble. Aluminum sulfate, 2 ounces to 1 gallon of water, to a cubic foot of soil, may be used to adjust the acidity. In most soils this amount will change the acidity from pH 6 to pH 5. In dry form about ⅛ pound to the bushel of soil will act similarly. Sulfur may be substituted, at half the rate of dry aluminum sulfate. The following fertilizer formula may be used in all potting soils for Camellias: five parts of cottonseed meal, three parts of superphosphate, and two parts of potassium sulfate. Likewise, this may be used as a top-dressing immediately following the blooming period, and a second application may be used 4 to 6 weeks later. A 5-inch potful of this mixture to a wheelbarrow of soil is sufficient. If plants fail to develop stiff stems by August, a light top-dressing of five parts of superphosphate and one part of sulfate of potash should be added. These recommendations are meant only for soils which are naturally deficient in the necessary elements. To make sure what is needed, the soil should be tested. It should not be too rich in nitrogen.

The time to water Camellias is before the soil becomes dry. Watering should be done thoroughly, and care should be taken to saturate the entire root system in the pot. When Camellias are growing actively and making leaf and wood, they require an abundance of water at the roots and over the foliage. After new growth has hardened, just sufficient water is required to keep the soil uniformly moist. The use of hard or alkaline water should be avoided. If it is used, care should be exercised to keep the soil adjusted to the proper acidity. Walks and foliage should be syringed frequently, and the humidity should not get below 50 per cent. Syringing plants when the flower buds are swelling helps to soften the outer bud scales and permits the buds to open freely. Wetting the flowers at night firms the texture of the petals and adds to the lasting qualities.

If Camellias remain in the greenhouse during the summer, give them all the ventilation possible. Give them partial shade by whitewashing the roof or using lath or cloth. It will be found more satisfactory, however, to plunge the pots out of doors in lath houses, under the shade of large trees, or in cloth houses. The last method is probably the most satisfactory of all. Do not allow direct drafts on plants while they are growing actively during spring.

The factors causing bud drop are lack of sufficient humidity, dry soil at the roots, and either high winter, or wide fluctuations of, temperature.

Prune immediately after flowering, cutting back to a strong, prominent bud of last season's growth; cut all branches having poor buds to good ones. To preserve symmetry of plants remove excessively long branches; this is best done when the new wood has started to harden. Allow but one flower bud to remain on each terminal branch if you want maximum perfection. This disbudding should be done when the buds are the size of a pea, and the smallest and weakest should be removed.

The following varieties are satisfactory:

NAME	COLOR	SEASON
Sarah Frost	Rose	December to February
Prof. C. S. Sargent	Red	November to March
Wilderi	Rose-pink	November and December
Marquise D'Exeter	Salmon pink	December to March
Cheerful	Rose-pink	December to February
Pink Perfection	Shell pink	November to March
Alba plena	White	November to January
Anna Zucchini	White	January and February
Concordia	Rose and variegated	December to February
Candidissima	White	January to March

Daily syringing will help greatly in keeping plants free of insects, particularly red spider, which is probably the most serious pest. Selocide is very satisfactory for controlling red spider, but it should be washed off within 30 minutes after the spray has been applied. Mealy bugs may be controlled by spraying with Lethane or Volck. Scales may be controlled by using high-pressure sprayers and spraying with oil emulsion or nicotine sulfate and soap solution.

CHRYSANTHEMUM

Pot Chrysanthemum culture is not difficult, but these plants should never be neglected. The cuttings should be started in March and April from stock which has been on the dry side during the winter months. Strong cuttings about 3 inches long placed in clean sand or a mixture of sand and peat will root in about 3 weeks and may then be potted into 2½-inch pots, in a sandy silt loam to which one-fifth part of well-rotted manure or peat moss has been added. During this stage of growth sufficient space should be given to prevent spindly stems.

The young plants should be pinched as soon as they are established. The first pinching should leave 2 inches of the stem, and the subsequent pinching should aim at the encouragement of later shoots and the shaping of the plants. Plants should be pinched after new root growth has developed so that not too great a check will be created and vigorous shoots will be promoted. The last pinch will vary with the variety, but will usually come by the end of July or early August. In case of short-day treatment the last pinch should be made the day the shading is started.

Potting should be attended to regularly before the plants become pot-bound. Any neglect in this respect will result in hardening of tissues and a definite check in growth from which the plants rarely recover. The soil mixture should be similar to that used for the initial potting, with an addition of a 4-inch potful of horn shavings and a 4-inch potful of 4-12-4 fertilizer to each wheelbarrow of soil. After the last shift, and before buds show color, weekly applications of liquid ammonium sulfate or nitrophoska should be made.

During 1935 a number of Ohio State seedling varieties were grown in the cloth house up to August 15. These plants were superior in shape and size to those grown in the greenhouse.

During the season of growth, frequent syringing of the foliage and weekly spraying with insecticides should be used, to keep the plants as healthy as possible. Staking is occasionally necessary, and disbudding may be practiced to produce larger flowers.

Any of the short, stocky-growing varieties can be used for pots. Local market conditions should be studied to determine the type which will sell the best. The present trend is toward the single and anemone types. Some of the better varieties are: Ethel, Wee Dot, Irene, Firebird, Togoya, Melba, Afterglow, Red Wilcox, Legal Tender, Stoplight, Ohio State, Gold Lode, Rose Cochard, Quaker Maid, Friendly Rival, and Old Rose.

For early September bloom the short-day treatment should be applied. Tests show that July 15 shading produced Ohio State by September 15; whereas August 15 shading came in October 1. A limited number of early pot chrysanthemums should be had, as there has been a fair market for some pot plants the latter part of September and the early part of October.

CINERARIA

The Cineraria plant makes an excellent subject for sale, blooming from January until May, depending upon the time of starting. For the January period the seed should be sown in June; this early sowing usually does not do as well as the July 15 to August 1 sowing, which flowers in February. For later flowering the seed is sown August 15 or later. Cineraria seeds are small and should be covered lightly and carefully in a soil mixture consisting of one-third soil, one-third sand, and one-third peat. Seedlings are first transplanted into flats, and later potted into 2½ pots, in one-fourth manure and three-fourths silt loam.

Fig. 5.—Top—Excess fertilizer on Cineraria. Left to right—normal; burning of foliage from over-abundance of nitrate nitrogen in the soil. Bottom—Effect of potassium in the growth of Cineraria. Soil pH=7. Left to right—high potash; low potash; very low potash

SOIL MIXTURE TESTS

In 1934 and 1935 a series of tests was conducted to determine the effect of soil mixtures on Cineraria. Plots which contained manure produced the largest and most stocky plants; plots containing leaf mold and sand were second and third, respectively; and plots which contained peat and soil produced very poor plants. Plots which received weekly applications of nitrogen in the liquid form were superior to those which did not receive additional nutrients.

ADDITIONAL ILLUMINATION

To study the effect of additional light on Cineraria, 36 plants were given 4 hours of additional light from 75-watt lamps which emitted 22 foot-candles of light, placed 44 inches from the top of the plants. The plants were selected from a large number to secure uniform height and number of leaves. Eighteen

plants were used as checks. Additional illumination was applied from January 26 to February 19. Those under light were in full bloom February 19; whereas the check matured March 14, 23 days later. The average height of lighted plants was 21 inches. Those in the check plot averaged 16 inches. Where earliness of bloom is desired, the use of additional light on Cineraria is of value.

Cinerarias should be grown in a cool house (45° to 50° F.) and given plenty of water. Aphids, white fly, leaf rollers, red spider, thrips, stem rot, and a number of other pests may be troublesome unless constant care is used.

CYCLAMEN

The Cyclamen was long considered the greatest favorite for Christmas bloom, but the newer varieties of Poinsettia have supplanted this old favorite.

The plants are propagated by seed sown from August until December in one-half silt loam soil and one-half German peat. All soil, flats, and pots should be steam sterilized to destroy the troublesome soil pests of the Cyclamen. Since the seeds are large and the seedlings remain in flats for a considerable time, they should be sown individually about 1 inch apart. A special board studded with rounded nails may be used as a marker to make depressions into which the seeds are placed. In a temperature of 55° to 60° F., germination will take place in 4 to 5 weeks. After two or three leaves have developed, the young plants may be transplanted to other flats or potted into 2½-inch pots. On a large scale, the seedlings are frequently set in greenhouse benches, spaced 3 inches apart. Because of the extreme susceptibility of the Cyclamen to nematodes it is necessary to steam sterilize all the soil used. Leaf mold has been the source of infestation in a number of cases.

The first transplanting should have the hypocotyl (commonly called bulb or corm) placed so that its top is even with the surface of the soil. Adequate drainage should be provided in the pots through the use of charcoal, gravel, or other coarse material in the bottom. The shift into 3-inch pots usually takes place in March, and into 4- and 6-inch pots later, as soon as the plants show signs of becoming pot-bound. At each shift the hypocotyl is elevated until at the last shift it is above the surface of the soil. Too many growers shift all their plants into the same-size pots. Each individual plant should be carefully examined and given a ½-inch shift rather than a full inch, if roots are not too large. A soil mixture of three parts of silt loam, one part of well-rotted manure, one-half part of acid peat, and one-half part of sand has given satisfactory results. The soil used for potting into 4-inch pots and larger should contain additional fertilizer in the form of 4-12-4, and horn shavings at the rate of a 4-inch pot for each wheelbarrow of soil.

After the plants have become established in the finished pots, usually 6-inch in October, biweekly additions of ammonium sulfate or urea should be made until November. This will produce exceptionally well-grown plants in 6-inch pots and eliminate the necessity of shifting into cumbersome large sizes.

General care consists of growing the plants in as cool a place as possible during the summer. A well-ventilated, partially shaded greenhouse is used. In October the shade should be removed and a temperature of 50° F., provided.

FREQUENCY OF WATERING

A study was made, with the variety Rose of Marienthal, to determine the effect of frequency of watering on growth and flowering and whether or not sprinkling over the foliage several times daily is beneficial. This experiment was conducted between July 4 and November 4, 1933. The plants were in 5-inch pots and were well rooted and growing when the experiment was started. The regular program of fertilization was followed, and each pot in the experiment was given the same fertilizer treatment. Ammonium sulfate in liquid form, 1 ounce to 2 gallons, was applied six times during the test.

Sprinkling overhead was done two to four times a day, depending on the weather conditions.

TABLE 5.—Effect of Different Amounts of Water and Sprinkling on Cyclamen

Treatment	Average number of leaves per plant	Average leaf area
		Sq. In.
Watered twice daily, sprinkled	25.4	10.4
Watered once daily, sprinkled	28.8	12.6
Watered every other day, sprinkled	27.2	12.5
Watered twice daily, not sprinkled	33.5	12.3
Watered once daily, not sprinkled	29.5	11.1
Watered every other day	16.6	10.8

The results in Table 5 show that watering twice a day without sprinkling produced plants as large as those watered once a day and sprinkled. Plants receiving water only every other day were least satisfactory, but with the advent of cooler weather in the fall they began to grow, and they were well formed but small. The plants which were watered twice a day and sprinkled were poor and not as well developed as those which were watered but once a day and sprinkled. More frequent watering, which would be more expensive, was found to be as beneficial as sprinkling. The walks were kept moist at all times during the experiment.

Staging on pots will produce earlier and better flowers because more air reaches the plants, and the soil in them will dry out faster.

It is possible to carry the plants over for the second year or longer by resting them after flowering, but such a procedure is not practiced commercially. Cyclamen may be propagated vegetatively by cutting the hypocotyl in sections with a leaf or two attached and rooting the sections in sand. If the propagating is done in January, this method will reduce the time necessary for maturity from 15 to 12 months.

Cyclamen stunt, a disease which produces necrotic areas, reddish-brown in color, in the hypocotyl tissues, shortens the petiole and peduncles and makes the flowers open under the leaves. No control is known, although careful steam sterilization of soil and pots is helpful. Crown rot and leaf spot are controlled with Bordeaux mixture. Mites, thrips, and aphids are the most troublesome pests; they are controlled by weekly spraying. Nematodes are controlled by steam sterilizing all material, including bench, soil, flats, and pots.

CYTISUS (GENISTA)

Genista plants are propagated by soft cuttings from stock plants in October and February. The early fall propagation results in slightly larger plants. Tests conducted at the Ohio State University showed that a bottom temperature of 65° F. and a top temperature of 60° F. gave the highest rooting percentage. A sand and peat medium was inferior to sand. Genista cuttings require a well-ventilated house and not too high a humidity. Rooted cuttings are potted in soil containing three parts of silt loam and one part of well-rotted manure.

SOIL MIXTURES

Soil-mixture tests were conducted in 1935 and 1936. Plot 1 contained composted soil; Plot 2, one-fourth peat and three-fourths soil; Plot 3, one-fourth leaf mold and three-fourths soil; Plot 4, one-fourth cow manure and three-fourths soil; Plot 5, one-fourth mushroom compost and three-fourths soil.

Plot 4, which received well-rotted cow manure, produced the best plants, and the flowers developed a few days in advance of those of the other plots. All plots receiving additions of organic matter were superior to the plot receiving composted soil. Ten plants were used in each plot, and all plots received a 4-12-4 fertilizer at the rate of a 3-inch pot per bushel of soil when shifted.

Genista plants should be kept pinched until the latter part of December. During the winter, a temperature of 40° to 45° F. should be maintained, but the temperature is raised to 50° F. for forcing. Post (5) found that temperatures above 65° F. prevented bud formation and that when plants were flowered February 15 and then placed in a 65° F. minimum temperature all flower parts dropped. After the flowers dropped these plants were pruned, grown at 45° to 50° F., and flowered the second time May 1.

Unsold plants may be sheared and grown similarly to young plants. Genista will not stand overwatering; therefore it is recommended that the plant be grown in the greenhouse all summer or in protected frames out of doors.

Red spiders and thrips are the most troublesome pests. Bacterial nodules should not be mistaken for nematode injury.

GARDENIA

Gardenias have great possibilities as pot plants, especially for Easter and Mother's Day. The high temperature and dry atmosphere in the average home make conditions unsuitable for Gardenias during winter, as the plants will drop their buds quickly. In early spring conditions are more favorable for them, and they are more useful then as house plants.

The consumer who plants Gardenias outdoors and brings them in early in the fall usually has good results. *Gardenia veitchi* is the commonest variety used for pot growing.

Gardenias are easily propagated by half-hard cuttings taken from December to March. These cuttings will develop into fine pot plants in a period of 10 to 15 months. An enclosed case with a bottom temperature of 75° F. provides the most satisfactory means of propagation.

ROOTING CUTTINGS

Cuttings will root in 4 to 6 weeks. After rooting, they should be potted in 2¼-inch pots, in a mixture of one-half peat and one-half soil. After potting, the young plants should be placed in a humid corner in a greenhouse, since they require high humidity and large quantities of water.

The small plants should be shifted gradually and never allowed to become pot-bound, to avoid a check in growth. A check caused by failure to shift or other cultural neglect is difficult, and in some cases, impossible to overcome. Shifting should never be done after September 1. Gardenias require a high humidity for best growth, but the plants should not be syringed overhead during the fall and winter, as this will encourage bud drop.

SOIL MIXTURES

In soil-mixture studies at the Ohio State University, it was found that the plots which contained one-third and one-half imported peat, with the remainder of the mixture good silt loam, produced the best plants. Mucky soils have also given promising results. Applications of a 4-inch pot of 4-12-4 fertilizer to a wheelbarrow of soil should be made at shifting. The addition of a 3-inch pot of iron sulfate (copperas) to a wheelbarrow of soil is helpful in the prevention of yellow foliage.

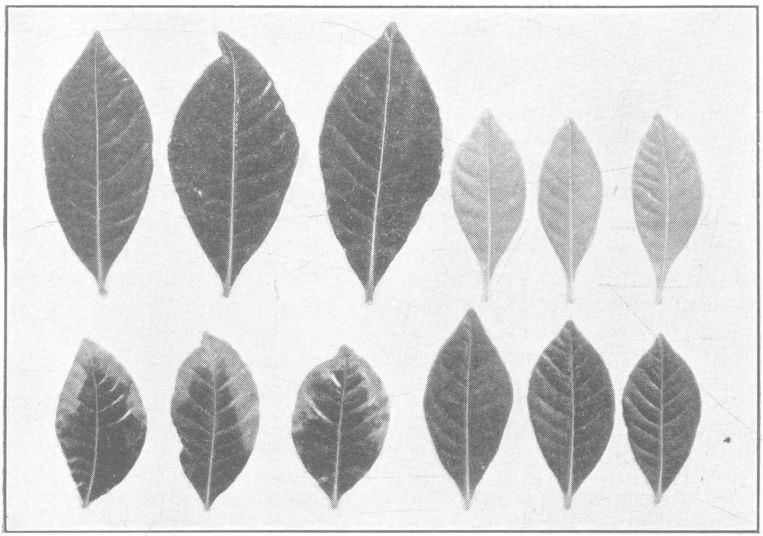

Fig. 6.—Gardenia foliage under various conditions of nutrient deficiency. Upper left, normal leaves; upper right, nitrogen deficiency; lower left, potassium deficiency; lower right, phosphorus deficiency

Gardenias respond to fertilizers that carry the nitrogen in the form of ammonia, such as tankage or ammonium sulfate. Ammonium sulfate applied in liquid form, 1 ounce to 2 gallons of water every 2 weeks, in the fall and spring is desirable.

Nitrogen deficiency causes a light yellow-green foliage with short internodes. Potassium deficiency is readily detected by the discolored margin of the older leaves and dwarfed growth. Lack of phosphorus causes small, dark-green leaves and short, stocky internodes. The symptoms of nutrient deficiencies are shown in Figure 6. Iron deficiency causes light yellow-green areas between the veins of the leaf. The veins remain a dark green at first and gradually become lighter in color.

GENERAL CULTURE

Well-shaped specimens are obtained by pinching the young plants when they reach a height of 6 to 8 inches. The vigorous shoots are kept pinched until August 15; the plants should be staked and tied at this time. It requires 12 to 15 weeks for a flower to come into bloom after the bud has formed. During the summer months, the vegetative stage of growth, the plants are grown at a high temperature and high humidity. The plants are continually dampened down overhead. This produces a rather soft and extensive growth. Ventilation is always reduced at night, regardless of temperature. This practice is continued through the summer until about the middle of August, the end of the vegetative period.

In order to have flowers by Christmas, buds must be showing by October 1. During the bud setting period dampening down is discontinued, and the houses are run as dry as possible; that is, with low humidity. The pots are run slightly drier but not enough to check root growth. If there is doubt concerning how dry to run the beds, it is better to maintain proper moisture, because the plants must not be checked in this manner. Low humidity and full ventilation are important. Full ventilation is given at all times, even at night, unless there are high winds. Temperatures are to be maintained as low as 50° to 55° F. This is continued until the third or fourth week in September. It must be understood that the plants are growing during this period but not as rapidly as during the early summer. By reducing vegetative growth an attempt is made to terminate that growth with a bud.

Toward the end of September, ventilation is reduced and humidity is increased. From this time on a temperature of 60° to 62° F. is maintained at night, and it should be maintained as evenly as possible. Humidity is raised extremely high for the first week, or until buds are noticed.

The bud development period is apparently a very critical time. During this period, from October to Christmas, the buds must continue to develop. Quite often, there will be buds, but they do not develop. Once they become hard, they will never develop, nor will they drop. The cause of this is not known, but plants have been checked, or at least their bud development has been stunted. Humidity should be carried high, approximately 80 to 85 per cent. During October and November the plants may be dampened down overhead, and the walks kept moist. During December just the walks are dampened down. This is sufficient to maintain humidity with the reduced ventilation. Ventilation and a buoyant atmosphere should be maintained at all times. Careful watching is required to maintain humidity with free ventilation, since it is extremely important. Humidity gives a control of bud development and adds size to the flower when it is ready to cut.

SUPPLEMENTARY ILLUMINATION

An experiment was conducted on the effect of supplementary illumination on pot Gardenias. The plants were grown in the cloth house and potted in one-third peat and two-thirds soil August 15. Twenty-five plants in 5-inch pots were in each of three plots. Plot 1 received 12 hours of additional light from two 150-watt lamps; Plot 2 received 6 hours of additional light from two 150-watt lamps; Plot 3 received no treatment. Lights were started October 25 and discontinued February 15.

TABLE 6.—Effect of Additional Supplementary Light on Gardenias

Treatment	Production	
	Number of salable flowers	Number of culls
Plot 1	150	28
Plot 2	185	20
Plot 3	67	24

The data show that 12 hours of additional light were less effective than 6. Both illuminated plots produced more commercial flowers than the plot receiving normal treatment.

OUTDOORS

Growing the plants outdoors in a frame or cloth house is satisfactory, and large plants may be obtained in this way. The plants should be planted 8 by 10 inches apart in a soil that has previously had an application of a complete fertilizer. After planting, which should be done in early June, the plants are mulched with peat. The plants should be pinched and fertilized similarly to those grown entirely in pots. They are lifted the last part of August and placed in a close atmosphere until they become established. The Gardenia should never be shifted after September 1 if early flowering is expected. Plunging potted Gardenias under cloth is also satisfactory.

Nematodes, mealy bugs, and stem canker are the most serious pests of the Gardenia. Plants infested with nematodes should be destroyed; steam sterilization of the soil is the most satisfactory preventive measure. Mealy bugs are controlled by spraying the plants weekly with Lethane 440. Stem canker is controlled by removing all diseased plants, sterilizing soil and tools, and propagating from disease-free stock.

GERANIUM

The sale of Geraniums for spring planting has been decreasing rapidly during the past several years, but, nevertheless, the Geranium is still the largest seller in bedding plants.

For best results stock plants should be grown inside rather than placed in the field. The plants should be planted in beds or benches in June, spaced 12 inches each way. They require a soil which is high in phosphate and potash. In preparing the soil, 20 per cent superphosphate is applied at the rate of 10 pounds per 100 square feet and potassium chloride, at 1 pound per 100 square feet. Nitrogen should be applied from time to time, but too high a concentration of nitrates will cause succulent growth which is detrimental to the production of Geranium cuttings. After the removal of a crop of cuttings, an

application of complete fertilizer (4-12-4), 1 pound per 100 square feet, is made and scratched in; then the plants are watered heavily. Oftentimes this watering will suffice for 2 months. Earlier cuttings may be obtained by growing stock plants inside, and a larger quantity may be expected. Cuttings are taken through the entire year, with the exception of June and July. At this time it is advisable to cut the plants back severely so that the stock plant does not grow too tall. The temperature need not be higher than 45° F.

In taking cuttings, at least one good bud, and preferably two, should be left on the stock plant. A Geranium cutting should be at least 5 inches in length, but the length will depend greatly upon the variety. The cutting should be trimmed and cut right below a node. The cuttings are placed in a coarse sand that has previously been treated with boiling water to control the damping-off disease. After sticking, the cuttings are watered well. Watering Geranium cuttings each day is a mistake. After the first watering, cuttings in the propagation bench require just enough moisture to prevent wilting of the foliage. Moist foliage increases the possibility of disease in the propagating bench. The temperature of the sand should be 55° to 60° F. and the top temperature, 5 degrees less. Cuttings are ready to remove 6 to 8 weeks after inserting, depending upon the time of the year.

Rooted cuttings are then potted in compost soil without the addition of any fertilizer. Extremely heavy soil should be mixed with one-quarter part of sand. In potting Geraniums, firmness is very essential.

Plants propagated in the fall will produce well-branched, 4-inch plants by May 30. Those propagated in January and February will produce good 3's and later propagation should be finished in 2¼'s.

To produce a well-branched plant, pinching is necessary. Plants should be hard pinched before February 15 and soft pinched not later than March 1, depending on the growth and establishment of the plant. The plants should be in 3's when pinched. When the plants are hard pinched, three to five leaves should be left; if internodes are long, only three should be left. A cutting is then made from the portion removed. Soft pinching should be done on shorter plants, never too high. It is well to allow the breaks to show before shifting into 4-inch pots.

For the final shift, add a 4-inch pot of superphosphate and 2-10-10 per wheelbarrow of compost soil. Geraniums should not be given very much nitrogen, as nitrogen induces vegetative growth and prevents flowering. The last shift should be given early in April. Plants which are pot-bound in 3-inch pots may be shifted into 4's as late as the first of May and still make Memorial Day. This should not be tried if the plants are not well established in 3-inch pots. After the plants are in the last stages, spacing is very important.

Watering is the most essential operation in making the Geranium flower for Memorial Day. The buds should show at least 5 weeks before the plants are wanted in flower. Geraniums should never be watered too frequently after they are in 4-inch pots. Running them as dry as possible will give short, well-flowered plants. The plants should be watered individually after the buds are appearing, as overhead moisture will cause poor flowers and sunscald spots on the foliage.

The most serious trouble with Geraniums is leaf spot. It can be controlled by keeping the infected plants isolated. Plants should be ventilated freely, kept on the dry side, and sprayed with colloidal sulfur. Another trouble which occurs and is often confused with leaf spot is a physiological leaf spot

caused by overwatering and poor ventilation. Some varieties, such as Suzanne, will occasionally produce blind wood. This kind of stock should be discarded. Fasciation is a disease of little importance. Black Leg is often troublesome in the cutting bench and in young plants; steam sterilization of the sand, bench, soil, and pots is advisable for complete eradication.

The most troublesome insect is the Mexican mealy bug, which is controlled with Lethane 440. Aphids, leaf tyers, and slugs are sometimes present.

The following varieties are considered among the best:

Light pink—Enchantress and Mrs. Lawrence
Salmon—Fiat, Mme. Landry, and Improved Poitevine
Brick red—Red Fiat
Red—Radio Red and Red Barney
Cerise—Suzanne
White—Mme. Buckner

GLOXINIA

Gloxinias are grown from seeds sown during January or February in pans of light, sandy compost. The surface should be made smooth, and the mixture should be watered before the seeds are sown, as they are fine. The seeds need not be covered at all, but if preferred, they may be covered carefully with a sprinkling of sand. The pans are placed in a warm house (60° F.) and covered with pieces of glass or paper which should be removed as soon as the seeds germinate to prevent trouble from damping-off. Losses from damping-off can be markedly lessened by using soil sterilized with steam. Care in watering is equally important.

The direct rays of the sun must not strike the plants at any stage of development, as the foliage is easily burned, especially if there is any water on the leaves.

When the seedlings are large enough to handle, they may be pricked off into pans of sandy soil, and when two or three leaves have formed, the plants should be transferred to flats and spaced about 3 inches apart. Some growers transfer seedlings directly from pans to flats. The next shift should be into 4-, 5-, or 6-inch pots, in which the plants will flower in the late summer and early autumn. A good soil mixture consists of three parts of silt loam, one part of well-rotted manure, one part of peat, and one part of sand.

If good tubers are desired, the seedlings should be planted about 10 inches apart each way in frames. Shaded sashes should always be kept over the plants, and the sashes should be lifted at both the top and bottom during the summer to provide good ventilation. Watering must be done carefully. Weekly spraying is necessary to control mite and thrip.

At the end of the flowering season Gloxinias should be dried off gradually. When the foliage has ripened the tubers may be stored in several ways. They may be stored in dry sand or dry peat after the soil has been shaken off them, or they may be left in the pots in which they bloomed if storage space is available. The storage temperature should not be less than 50° F.

Tubers may be flowered for several seasons; those 1 or 2 years old produce the best plants. For early bloom, tubers should be started in January or February and handled similarly to tuberous-rooted Begonias.

HYDRANGEA

The Hydrangea is a valuable pot plant for Easter, Mother's Day, and Memorial Day. The culture of this worth-while plant is difficult. To produce good plants, a thorough understanding of the many factors which affect the plant is necessary.

The culture of the Hydrangea may be taken up in two sections, the summer growth and the forcing. The best specimens come from the earliest cuttings which are taken in February from plants forced for Easter. Unfortunately, the better varieties do not produce many shoots that can be used for cuttings. Stock plants of such varieties should be kept for cuttings only. Some growers prefer late fall cuttings, which are carried over winter in 2-inch pots. This type should be repotted to 3-inch pots after growth has started, so that the plants can become established well enough to be topped in March. The Hydrangea cutting will root easily in sand with a bottom temperature of 70° F. It must not be propagated in a closed case or rot will destroy a high percentage of the cuttings. The cuttings should be potted in a soil that is porous and not too heavy. A mixture of two parts of loam, one part of imported peat, and one part of well-rotted manure is satisfactory. Cuttings taken in February and March will require shifting into 3-inch pots some time in early May.

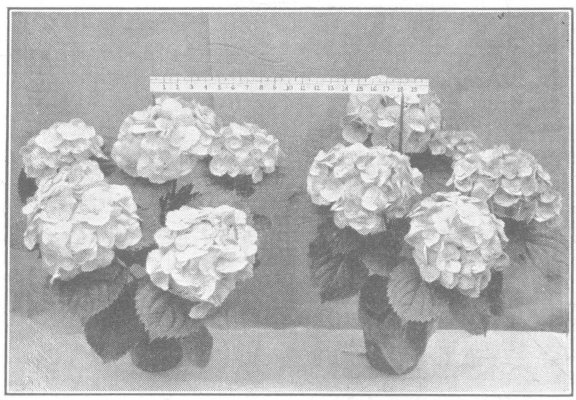

Fig. 7.—*Hydrangea hortensis* **variety Europa**

The pot and field methods of growing Hydrangeas have been subject to debate for a number of years. Both have their advantages. Growers located in limestone regions or in cities with very alkaline water should not attempt pot culture, as pot growing requires frequent watering and, consequently, high amounts of lime accumulate and the soil becomes alkaline, which is detrimental to the Hydrangea. Even if aluminum sulfate is used to change the reaction, the alkaline water nullifies its effect in a very short time. Growers in localities having naturally acid soils have very little difficulty in growing the Hydrangea in pots all season. Some growers prefer to keep the plants in the greenhouse until August 1. The plants are usually shifted into 4-inch pots in June. August 1, the plants are removed from the greenhouse to frames out of doors. In early September the plants are shifted to 5½- to 6-inch pots.

For the field method, irrigation of some form is very essential. Field-grown plants are always larger and their wood is much thicker, giving a better foundation for forcing. Many growers forget that the buds of the Hydrangea are formed during the autumn, and that proper fertilizing of the plants is necessary then. Blindness is attributed to the low amount of potash and phosphate in the soil. An application of a complete fertilizer at the rate of 4 pounds per 100 square feet before planting in the field is desirable. In potting soils, a 4-inch pot is used for each barrow of soil.

The soil required for proper growth is very seldom found naturally. Conditioning the soil with applications of sand, peat, and manure is necessary. The soil should be porous at all times, be able to retain large amounts of water, and yet be fertile. To produce such soil which is slightly acid is difficult the first year. Sandy soils are often deficient in potash and phosphate and produce large, well-shaped plants which fail to flower.

If the soil is naturally acid and you wish the Hydrangea to come pink, add 8 pounds of agricultural limestone per 100 square feet, or a 4-inch pot to each barrow of soil. It is well to know your soil acidity, and this may be obtained from your experiment station.

Pinching the Hydrangea is very important. Early propagated plants will require a topping the latter part of May or shortly after they are planted in the field. The second pinching should be no later than July 10. It is true that late pinching will result in short plants, but such a procedure will cause blindness. The period after a pinch is one of the most critical in Hydrangea culture. If hot weather prevails for several days, the young breaks will be checked and a poor plant will result. The use of lath shades is helpful in carrying the plants over this critical period. In the cloth house Hydrangeas will develop into large plants at a much lessened expense to the grower. Growers having trouble producing plants will find the cloth house of considerable help. Pot culture should be used when growing plants under cloth.

The Hydrangea requires large amounts of fertilizer during the growing season; several applications of a complete fertilizer (4-12-4) at the rate of 2 pounds per 100 square feet should be made during the summer. The last application should not be later than August 15.

Plants should be lifted from the field in September and potted in a soil that contains at least one part of peat and one part of well-rotted cow manure to three parts of field soil. A 4-inch pot of 4-12-4 fertilizer is added to the barrow of soil, and a 3-inch pot of sulfur is added if the soil is neutral or alkaline. Pot-grown Hydrangeas should be shifted during the latter part of July in order to have the plant pot-bound by September. Liberal feeding with complete fertilizer is recommended.

The hardening-off process may be carried on in any cool place. A dark, cold, moist pit or lean-to is desirable. If the heat is lowered gradually, the Hydrangea will stand temperatures as low as 20° F. in the middle of December. Plants kept in a dark place with a gradually lowered temperature will drop their leaves and be ready for forcing earlier than plants kept in the light. This darkening period should start after November 1 when the outside air temperature ranges about the freezing point. Keeping the plants too dry in this stage will cause injury to the stem just under the bud.

THE FORCING OF THE HYDRANGEA

Plants should be brought on top of the bench shortly after Christmas. The starting temperature should be between 54° and 56° F. At first, the plants should be kept on the dry side, and the tops should be syringed frequently to induce the buds to break. As soon as growth starts, the temperature is raised gradually and the plants are watered more freely. At a temperature of 65° F. 6 to 8 weeks when the bud is the size of a pea, or 4 weeks when the bud is the size of a nickel, are required to produce a salable plant.

COLORING AND FERTILIZING HYDRANGEAS

The fact that pink-flowering *Hydrangea hortensis* could be changed readily to a blue color has been known for a long time. The reasons given for this color change were a matter of dispute until Allen (1) presented definite results showing that aluminum was the sole factor in this change. Chouard (2) reported that iron, chromium, and aluminum could be the bluing agents.

During the past 4 years experiments have been conducted by the writer at the commercial greenhouses of Walter J. Engel near Columbus to determine the possibility of coloring and fertilizing Hydrangeas on a commercial scale.

1933 results.—On January 14, 11 plots, containing 70 plants each of the varieties Goliath and Gertrude Glahn, were started to determine the number of applications of aluminum sulfate necessary to produce the blue color. In addition, three different fertilizers were applied to plots receiving aluminum sulfate. The soil was tested for acidity with the Morgan Set at weekly intervals.

Aluminum sulfate was applied in liquid form at the rate of 1 pound to 5 gallons of water and in the dry form at ½ teaspoonful per 6-inch pot. The initial soil tested slightly alkaline (pH 7.2).

TABLE 7.—Comparative Changes in pH

	Jan. 14	Jan. 21	Jan. 28	Feb. 3	Feb. 10	Feb. 18	Feb. 25	Mar. 10
No treatment	7.2	7.0	6.8	6.6	6.6	7.2	6.8	7.0
Aluminum sulfate, liquid form	7.2	6.0	6.0	5.8	5 6	5.0	5.0	5.8
Aluminum sulfate, dry form	7.2	6.0	5.5	5.6	5.7	5.2	5.6	6.0

Seven applications of aluminum sulfate were made during the period from January 14 to March 10. The pH was determined 1 week after the application. In several instances the pH was determined the day after the aluminum sulfate was applied. On February 10 the soil tested pH 5.6, and one day after the application of aluminum sulfate the pH was 4.0. At this pH, considerable leaf drop was noticed, in addition to the bronzy coloring of the leaves which remained on the plant. The pH reading varied with the location of the soil sample. The soil samples were taken from the lower portion of the pot where white roots were most abundant. Table 7 shows that the pH readings did not lower uniformly. The reason for this is that alkaline well water was used when rain water was not available. When the soil tested pH 6.0 or lower, bluing resulted, although the blue color varied with the variety. Goliath produced a good blue color at pH 6.0; whereas Gertrude Glahn produced a dark lavender color at the same pH reading.

1934 results.—A test similar to that of 1933 was conducted in 1934-1935. A larger list of varieties was tested to determine those that would be best suited for bluing.

Table 8 shows that lowering the pH with aluminum sulfate is a slow, gradual process. When heavy applications of aluminum sulfate were made to plants that did not show good root development, burning of the foliage resulted. Chlorotic plants usually had a poor root system, and applications of aluminum sulfate did not correct this yellow condition. To the plants which showed a mild case of chlorosis and had a fair number of active roots, aluminum sulfate proved directly or indirectly beneficial.

TABLE 8.—Weekly pH Readings

	Jan. 24	Jan. 31	Feb. 7	Feb. 14	Feb. 21	Feb. 28	Mar. 7	Mar. 14
No treatment	6.8	6.8	6.8	6.6	6.6	6.8	7.0	6.8
Aluminum sulfate, liquid form	6.8	6.6	6.2	6.1	5.9	5.7	5.9	5.7

Goliath, Blue Prince, and Kunert responded very well to bluing; these varieties changed to a very attractive, clear blue. Gertrude Glahn and Europa did not color a clear blue but carried more lavender and purple shades. Parsifal, Deutschland, and Ruby produced extremely dark-blue colors. The sepals carried a darker shade along the margins and a lighter tint near the center of the flower. Hollandia and M. Baardse produced dark-blue colors that were not as attractive as the above-named varieties. Lorelei and La Victoire were not satisfactory for bluing. Neidersachsen changed to a light blue; Mme. E. Mouillere remained white.

The varieties which were naturally medium pink in color produced a better blue color than the dark-pink varieties.

1935-1936 results.—To determine the number of applications of aluminum sulfate for complete coloring, a series of plots was outlined in which acidity readings were taken weekly at both the top and bottom of the pot. An application of ½ pint of aluminum sulfate, ½ pound per 5 gallons of water for the first application and 1 pound per 5 gallons of water for the remaining six applications, was given to each plant. Goliath and Gertrude Glahn were used throughout this test.

The results with Goliath were as follows. One application did not change the color; two applications gave a poorly colored flower with tones of blue mixed with the pink. Three applications produced the first definite blue colors, and four to seven applications, a true Hydrangea blue color. The larger number of applications caused some burning on the margin of the leaves. Gertrude Glahn results were similar to Goliath.

In some parts of the country pink Hydrangeas are more difficult to obtain because of the large amounts of aluminum existing in the soil. Tests were carried out with applications of hydrated lime, 1 teaspoonful each week, to produce the effect. All plants produced pink flowers.

It was noted in other years that occasionally the blue-colored flowers were not clear blue. After three applications of aluminum sulfate solution, ferrous sulfate, 4 ounces per 5 gallons of water, was applied each week for 3 successive weeks. Plants treated this way produced clearer blue flowers than the plants receiving aluminum sulfate throughout the test. Iron apparently has some bearing on the clearness of the blue color.

TABLE 9.—Comparative Changes in pH with Varying Applications of Aluminum Sulfate

	Original		One application		Two applications		Three applications		Four applications		Five applications		Six applications		Seven applications	
			Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Jan. 17	7.5	7.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jan. 24	.....	.....	7.0	7.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jan. 31	.....	.....	7.2	7.5	6.2	7.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Feb. 7	.....	.....	7.2	7.5	6.0	7.2	6.2	7.0	.....	.....	.....	.....	.....	.....	.....	.....
Feb. 14	.....	.....	7.3	7.5	7.0	7.5	5.5	6.0	5.0	5.5	.....	.....	.....	.....	.....	.....
Feb. 21	.....	.....	7.0	7.0	5.5	7.0	6.0	6.0	5.0	5.5	4.5	5.0	.....	.....	.....	.....
Feb. 28	.....	.....	7.0	7.0	6.2	6.5	6.5	7.0	5.0	6.0	5.0	5.5	4.5	5.0	.....	.....
Mar. 6	.....	.....	7.2	7.5	6.5	7.5	6.5	7.0	5.5	6.0	5.5	6.0	4.5	5.0	4.5	5.0

FERTILIZER EXPERIMENTS

In addition to the color experiments, fertilizer tests were conducted on the same plots that were treated with aluminum sulfate. Ammonium sulfate was applied at the rate of 1 ounce to 2 gallons of water; urea, at the rate of 1 gallon to 7 gallons of water; and 4-12-4, at the rate of ½ teaspoonful per 6-inch pot. The fertilizer was applied February 3 and biweekly thereafter until April 1. The 4-12-4 fertilizer produced extremely large flowers and leaves. Ammonium sulfate produced large leaves, but the flowers were not as large as those resulting from the complete fertilizer. Urea produced plants which had large flowers, but the leaves were light green in color.

Another fertilizer test was started February 3, and the materials were applied every 2 weeks until April 1. The following fertilizers were used: 4-12-4, 10-5-3, 15-30-15, urea, ammonium sulfate, 5-10-4, blood and bone, and bone meal. Ammonium sulfate, urea, and 15-30-15 were applied in liquid form; the others were used in dry form. Each plot contained 28 plants of the variety Gertrude Glahn.

Ammonium sulfate, 4-12-4, and 5-10-4 produced the largest flowers and, in general, were similar in effect. They all produced very large, green foliage on well-shaped plants. Fertilizers 15-30-15 and 10-5-3 produced soft stems and flower heads that were too large for the strength of the stem. Urea produced light-colored leaves but large flower heads. Blood and bone, and bone alone produced smaller plants and flowers than the other materials.

The Hydrangea should have a well-established root system before any forcing or fertilizing is attempted. Keeping the plant moderately dry at the roots at the time of starting will hasten root development.

The plant should be turgid when chemical compounds, such as fertilizer or aluminum sulfate, are applied. It is well to water the plants first, then apply the chemical compound, and then water this material into the soil. The plants should not be allowed to dry out for several days after the application. With these precautions, burning will not occur.

When the acidity was lowered to pH 6.5, a slight color change in the flower resulted. However, for complete bluing, the soil should test pH 6.0 or lower. Slight injury resulted from aluminum sulfate when the acidity was pH 4.0.

Hydrangeas responded to heavy fertilizing. Ammonium sulfate and complete fertilizers produced larger plants than did blood and bone or bone alone.

Pests which attack the Hydrangea are: mildew, red spiders, and aphids. The first is easily controlled with sulfur, either as a dust or painted on the steam line. It is a good practice to fumigate with sulfur at least every week or 10 days to prevent any such injury. The plants are syringed with a good force of water for red spiders. Frequently, crinkled leaves are noticed on the new growth just after it starts to grow. This crinkling is the result of insect trouble in the field or during the hardening-off stage. Red spider and aphids are the most common causes, but occasionally mites or thrips will cause this injury.

COLOR OF FOLIAGE

Yellowing of the foliage around the margin of the leaf and between the veins while the veins remain a dark green is a symptom caused by either (a) an insufficient root system, (b) overwatering, or (c) an alkaline soil and iron deficiency. The most common of these causes is the growing of Hydrangeas in an alkaline soil with high amounts of soluble lime.

Preliminary studies of chlorosis of the greenhouse-grown Hydrangea were started in 1934. Chlorosis in Hydrangea shows in the form of light-green areas between the veins of the leaves. In extreme cases these areas fade to a light yellow. The veins remain a normal dark-green color. Such a condition occurs very frequently when plants are watered too heavily before sufficient roots have developed. However, in this study the plants which were chlorotic had good root action and were not overwatered.

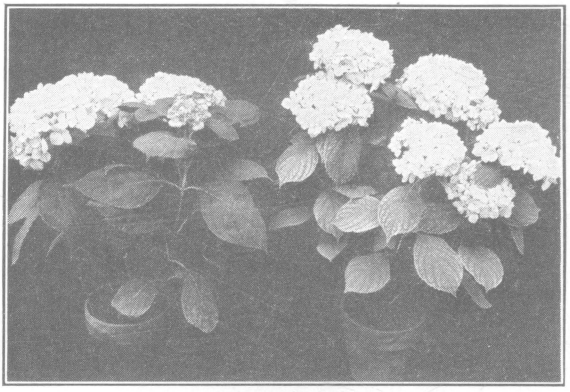

Fig. 8.—Chlorosis of *Hydrangea hortensis*
Left—Plant received ferrous sulfate.
Right—Plant received no treatment.

The variety La Victoire was used in the tests because it was the only one that showed typical symptoms of chlorosis. The plants were grown in the field the previous year and potted in September. The growth in the field was normal. The chlorotic condition appeared shortly after the forcing period started in January.

A series of 4-inch pot plants was treated with zinc sulfate, manganous sulfate, ferric sulfate, and ferrous sulfate. The plants received 1.5 grams of the first three chemicals and 0.8 gram of ferrous sulfate each week for 4 successive weeks. At the end of the second week the ferrous sulfate plot became much greener, and it remained green throughout the growth of the plant. Ferric sulfate benefited plants to a much less degree than ferrous sulfate. Zinc sulfate and manganous sulfate did not correct the chlorotic condition of the plants; plants treated with them remained the same as the check plants.

In another series the same chemicals were applied in liquid form, at the rate of 4 ounces to 5 gallons of water. Six-inch plants were used; each received 1 pint of the liquid each week. Similar results were obtained in this series. The plants receiving ferrous sulfate returned to the natural green color within 3 weeks; whereas the plants receiving zinc and manganous sulfate remained chlorotic. Ferric sulfate gave partial recovery.

The soil acidity was tested at weekly intervals and the check plants varied from pH 6.3 to 7.6. The plots receiving the chemicals were slightly more acid, ranging from pH 6.1 to 7.6.

During the past few years a number of new varieties have been introduced. Europa, Hamburg, and Altona are very similar, dark pink in color on strong, stocky stems. Schadendorf's Perle, Kunert, Merveille, and Rosebelle show promise. All of these varieties make short plants.

KALANCHOE

In an effort to develop new potted plants, Robert Blossfeld, German hybridizer, introduced *Kalanchoe Blossfeldiana*. This plant, with its brilliant scarlet flower, is a continuous bloomer from early October until May. Although it is a coolhouse plant, specimens brought into a 60° to 65° F. house early in November will be in flower in January; whereas if the temperature is kept at 50° F., the plant will flower from March 15 to April 15.

SHORT-DAY TREATMENT

Kalanchoes given short-day treatment similar to that used for chrysanthemums (4), will come into full flower in December or even earlier. Plants receiving short-day treatment from July 20 until September 20 flowered October 20, and plants receiving treatment from August 15 to October 1 flowered from December 1 to 15. Shading from September 1 until October 20 produced plants which were in full flower for Christmas. The black cloth was applied at 5 P. M. and removed the following morning at 8 o'clock.

Kalanchoes propagate readily from seeds, leaf cuttings, and stem cuttings. Seedage is by far the best method for the commercial man; the other two are slower methods, and the plants rarely attain the size of specimens grown from an early sowing of seeds.

Leaf cuttings taken with a small portion of the stem will develop into good plants. The leaf cuttings should be kept on the dry side in the propagation bench; otherwise rot will develop quickly. When the plant is large enough, it is potted in 2¼-inch pots and handled similarly to seed-grown plants. Simple stem cuttings removed from established plants in June and July make small, late-flowering plants. Seeds should be sown in January for early plants. Later sowings producing smaller and later-flowering plants can be made up to July.

A mixture of half loam and half peat has given good stands of seedlings. If the soil is heavy, it is desirable to add a small quantity of sand. The medium should be steam sterilized to prevent damping-off. Seed pans should be watered from the bottom, as overhead watering will result in loss of plants. Kalanchoe seeds germinate within 10 days in a temperature of 65° to 70° F.

When the seedlings are large enough to handle, they are transplanted into flats or pots. Some growers prefer placing two plants in a 2¼-inch pot to planting singly, which tends to develop bushiness. Plants pinched in June and July will not flower as early as those not pinched. The tops taken from these plants root readily and will make good short plants for later bloom. Individual plants are not as satisfactory as the made-up plants. Three 2¼-inch plants in a 6-inch pan develop into perfect rounded specimens. A good, well-drained, composted soil with little fertilizer is recommended. Kalanchoes will grow in a variety of soil types. The only fertilizers which have given any benefit are light feedings of urea or ammonium sulfate.

Kalanchoes planted out and cultivated in cold frames or cloth houses during the summer grow much quicker and are better branched than those grown in pots during the summer months. The plants should be potted late in August in pots that are not too large. Kalanchoes do not make a large root system; therefore overpotting should be watched. After potting, the plants should be placed in partial shade, with abundant ventilation. Close and damp atmosphere will cause stem rot.

Fig. 9.—Effect of short-day treatment on *Kalanchoe blossfeldiana*
Left—No treatment
Right—Short-day treatment from September 1 to October 20. Picture taken December 8

To grow fine, compact potted plants, as much light as possible should be given in winter; otherwise, the flower spikes grow too long. The plant should not be watered overhead during the winter months. If it is kept on the dry side, little trouble will result. Placement of pots on stages or on other pots is conducive to quicker flowering.

Kalanchoe enemies are damping-off organisms, stem rot, mites, and mealy bugs.

PELARGONIUM

Cuttings can be taken from stock plants in the fall, winter, and spring. Usually, these are potted into 2-inch pots after being rooted in sand. Soil for this potting should be sandy loam with no fertilizer or manure incorporated. After the cuttings are potted they should be watered immediately and watched closely, so that they do not wilt before they have had a chance to root. Protection from the sun and wind should be given by the use of papers for the first few days after potting. Shading should be used as little as possible, just enough to prevent wilting. Naturally, in the winter very little shading will be needed, but during the brighter days more will be required.

Most growers find it more satisfactory to purchase rooted cuttings or young potted plants from a specialist.

Grow the cuttings in a house averaging about 50° to 52° F. at night. When they have rooted, shift them to 3-inch pots using heavier compost; the best soil is composed of one-fourth well-rotted manure and three-fourths heavy loam. Add to this compost a 4-inch potful of 4-12-4 fertilizer for each wheelbarrow of soil. Give the plants plenty of space after they start to grow in 3-inch and larger pots. Crowded plants will be tall and slender. Use drainage in all pots 4 inches and larger. Use about the same compost when shifting to 4-inch and larger-size pots. Keep the young plants shifted and never let them get pot-bound. Be careful not to overwater the plants during the fall and winter and never water overhead after the plants have been shifted to larger pots. The flowers will hold their petals better after leaving the greenhouse if the plants are run on the dry side when in bloom.

For large plants for Easter, Mother's Day, and Memorial Day sales, it is advisable to purchase rooted cuttings or 2-inch plants during the previous spring. Cuttings taken during late spring are from blooming shoots and do not make as good plants as those propagated earlier.

Pelargoniums grow much faster than Geraniums after they are established in 2-inch pots, but make fewer cuttings and are difficult to root.

HANDLING LEFTOVER PLANTS

Any plants which are not sold can be cut back and grown on for the following year. In September, prune them into shape, removing all weak and soft shoots. Shake off old soil and repot in a light compost into the smallest-sized pots that will hold them. After potting, soak the plants well and place them in a cool greenhouse. Grow them on in a house averaging about 50° F. at night. When they are well rooted repot them in a richer soil. Pinch or top to form a branched, bushy plant. Be careful in watering in the dark days of winter. Artificial feeding can begin in February and March with a complete fertilizer, such as a 4-12-4. To lengthen the blooming season, give the plants a slight shade in May.

Pinch or top during November, December, and January for March and April blooming, during January and February for Mother's Day, and during February and early March for Memorial Day. Easter Greeting and its three sports, Mrs. Layal, Springtime, and Edith North, will bloom sooner after pinching than the other varieties. Usually, only the tips should be pinched out. This will make breaks lower down and form a branched plant. Pinch when the plant is in active growth between pottings and not at the time of repotting. Pelargoniums can be grown without pinching and will bloom earlier than if pinched.

The only objectionable feature of Pelargoniums is that they sometimes shatter some of their petals when they are taken from greenhouse conditions to a store or residence. During the last two seasons some growers have used a thin liquid glue with an eye dropper, putting two drops in the cup of each flower. This will glue the base of the petals together, and they will not shatter. After the glue dries it can hardly be seen. Other flowers that open later become acclimated to the store or residence atmosphere and will hold their petals.

A few of the better varieties are Azalea, Edith North, Springtime, German Glory, Easter Greeting, Lucy Becker, Wurtembergia, Swabian Maid, Gardeners' Joy, Pride of Quedlinburg, Improved Mrs. Layal, Prince Bismarck, Wolfgang Goethe, The Princess, Beautiful, Lavender Queen, and Diener's Giant.

The most troublesome insects of the Pelargonium are white fly, mealy bug, thrips, and aphids. Leaf spot is the only important disease, and it can be controlled by sanitation and spraying with Bordeaux mixture.

POINSETTIA

STOCK PLANTS

When Poinsettias are through flowering, early in January, the stock plants are selected and generally placed under the benches for at least 10 weeks. Here they are allowed to become dry, but not so dry that the wood will shrivel. They should be kept in a house with a temperature of 50° to 60° F. About the middle of April the soil should be shaken off the roots and the plants should be potted in new, rich soil. They are then cut back and placed in direct light where they will get some bottom heat. Holding over stock plants is a problem if the plants are allowed to dry out too much. Cuttings taken from old stock plants root more easily than those from new plants.

The use of California stock is constantly increasing. This stock is very dependable and provides a reliable source for good, strong cuttings. It usually arrives the early part of April and should be potted or benched immediately. Those who do not take care of their new stock shortly after arrival will have considerable trouble in making the plants grow. Similar stock may be produced by the grower himself, by planting leftover stock outdoors in the spring and lifting the plants before frost in the fall. These plants may be used for propagation the following spring.

The soil used for planting stock plants should be rich. It should be porous to provide good drainage. A soil composed of 3 parts of silt loam and 1 part of well-rotted manure, to which a 4-inch pot of superphosphate per wheelbarrow of soil has been added, has given good results.

The stock plants should be fed with a weak solution of nitrogen (urea, 1 ounce to 5 gallons of water; or ammonium sulfate, 1 ounce to 2 gallons) every 2 weeks after growth has started. A mulch of cow manure shortly after the first crop of cuttings has been taken may be used to keep the pots from drying out.

PROPAGATION

Different propagation media, including various grades of clean sand in comparison with combinations of sand and peat, have been used in tests with Poinsettias. The sand medium proved most satisfactory. The sand should be clean and free from decaying organic material, as well as small soil particles, which are all too common in propagation sand. The sand must be free of disease organisms, and the only assurance of disease-free sand is steam sterilization. The use of potassium permanganate, 1 ounce to 1 gallon of water, has given partial control of damping-off. This material should be added to the sand 24 hours in advance of the time the cuttings are to be stuck, and the sand should be thoroughly saturated with the solution. Boiling water treatment has proved more effective against damping-off where the entire bench has been saturated with the boiling water.

The size of the particles of sand has considerable effect upon the rooting of Poinsettias. A sand composed of medium-sized particles is superior to fine or coarse sands. The sand should drain easily and yet hold sufficient water. The depth of the medium varies from 3 to 4 inches. It is well to provide additional drainage by placing gravel to a depth of ½ inch at the bottom of the bench.

The bench selected for propagation should be away from any drafts but should be in a ventilated position. Many growers like to propagate in a closed house. Where large numbers are to be propagated it is best to use the entire house. In this case, a muslin shade should be constructed overhead inside the house. If the grower is propagating a limited number it is advisable to have the space equipped so that muslin may be stretched over the cuttings. In addition to the muslin shade, a heavy shade should be placed on the glass.

TAKING THE CUTTINGS

Two methods of taking cuttings are in common practice today. The first is to remove the cutting very close to the old stem. The second is to allow two leaves to remain on the new growth. The latter method will produce larger cuttings later in the season. Sufficient leaf area should be left on the stock plants to produce food for the new growth.

The time of day to take cuttings is important. Early morning when the plants are turgid is the ideal time. Poinsettia cuttings should be at least 4½ to 5 inches in length. When the cuttings are made, one to two leaves are removed, and then the cut is made through the dark-green layer which encircles the stem. This area is just below the leaf, and the stem is solid at this point. These cuttings should be dropped into cool water (52° to 56° F.) for a short time, never over 5 minutes.

Do not crowd the cuttings in the propagating bench, as crowding causes the leaves to drop and encourages disease. After the cuttings are inserted, the sand should be packed sufficiently. When cuttings are taken during cloudy days shading with paper is not necessary, but in case of sunny weather it is necessary to shade with paper for at least 3 days, and not longer than 4 days, in addition to the other shading material mentioned previously. The tops should be syringed at least every 2 hours during the day. Late in the evening the papers should be removed, but they should be replaced the following morning. Cuttings should show signs of rooting within 16 days and be ready to remove at the twenty-first or twenty-eighth day, depending upon the variety used.

Bottom heat should be supplied in early June and late August and September to promote root growth. Electric hotbed cable or steam may be used to supply this added heat. The bottom temperature should not be above 75° F. Cuttings may be taken as late as September 10, but this late propagation will make short, stocky plants.

After the cuttings have rooted they should be potted in a mixture of two parts of silt loam, one part of well-rotted manure, and one part of sand. Very little fertilizer should be added to the Poinsettia soil in this stage unless the soil is extremely low in fertility. The newly potted cuttings should be kept in a shady location for several days and given a syringing in the form of a mist every 2 or 3 hours.

The June and early July propagation may be used to produce double stems. The time to remove the tip will depend upon the amount of growth present. The plant should be allowed to grow until a good cutting may be removed. Cuttings taken from such plants root very readily.

PINCHING

It is advisable to pinch Poinsettias before September 4. Later pinching often results in blind growth or inferior bracts.

PANNING

The time of panning the Poinsettia will depend somewhat on the desired height. Early panning (September 25) will produce plants taller than panning October 10. Holding the plants in 2½- or 3-inch pots too long is detrimental, but growing the plants on the dry side will help reduce the height. The soil used for the final shift should be similar to that used in the first potting plus the addition of a 4-inch pot of horn shavings and a 4-inch pot of superphosphate to a wheelbarrow of soil. Peat should not be added to Poinsettia soil in any form, for the Poinsettia requires a soil which drains freely, and peat added to the soil will prevent this free drainage. Delayed flowering and dropping of leaves result when peat is used in Poinsettia soil.

Heavy applications of fertilizer are very harmful to Poinsettias. This plant should be fertilized frequently, but with dilute concentrations for best results. Feeding nitrogen before the bracts begin to show color may result in blind growth. Liquid fertilizer should be applied shortly after color develops.

During the past 2 years new Poinsettia containers have been developed. The clay pan which has been in use for a number of years has been improved and made deeper, and is now called the Poinsettia pan. This new type of pot carries more soil and is an improvement over the regular pan. Wooden tubs have likewise become useful, and in sizes over 8 inches they are cheaper than pots. When growing plants in wooden tubs the grower must be more careful in watering, since tubs hold water to a greater extent than pots.

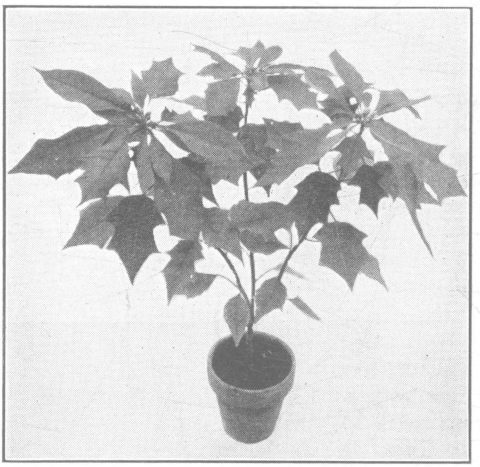

Fig. 10.—Poinsettia var. Ruth Ecke, showing freeness of branching

In panning, an empty 2¼-inch pot is placed in the center of the pan and left there until shortly before Christmas; then the pot is removed and a fern is inserted in its place. Unless this is done, the roots will be disturbed and the foliage will drop. Planting the ferns at the time of panning is not advisable because the ferns get too large and have a tendency to rob the Poinsettias of needed nutrients. Several varieties of *Pteris cretica* and *P. tremula* are used for this purpose, and occasionally, Nephrolepsis, *Asparagus plumosos*, or a variety of succulents.

The ideal growing temperature is 60° to 65° F. Overwatering, chilling, and drafts may cause yellowing and dropping of leaves. If the temperature is kept above 62° F., very little trouble from overwatering will occur. It is false economy to grow the Poinsettia without any artificial heat after October 1. Many troubles result and the plant is ruined because of improper temperatures. Bracts should show color before Thanksgiving to be in full flower for Christmas.

The chief insect enemies of the Poinsettia are the mealy bug and scale. It is well to have the plants clean before the bracts show color. Lethane 440 has given good results in controlling these pests.

DEFICIENCY SYMPTOM TESTS

Experiments to determine the symptoms of nutrient deficiencies were conducted at the Ohio State University in 1934.

Complete.—Plants given a complete fertilizer were vigorous in growth, of a normal dark-green color, and showed no loss of leaves.

Minus nitrogen.—Plants with a nitrogen deficiency showed a uniform yellowing of all leaves, beginning with the bottom leaves and progressing to the top. The older leaves dropped when they became pale yellow in color and before drying.

Minus phosphorus.—The plants were stunted, and grew little after being placed on the minus-phosphorus treatment. The older leaves began yellowing from the margins toward the center and dropped before they became completely yellow. All leaves dropped in succession until only the young bud leaves remained; they were dark green in color.

Minus potassium.—Plants grown without potassium were only partially stunted in growth. The older leaves began to turn yellow along the margins, and the yellowing progressed until the entire leaf was yellow, except for the dark-green veins. After yellowing, the leaves began to turn brown along the margins. They remained attached to the plant for a long time after drying. All the leaves were affected except the young bud leaves at the tip; they remained dark green in color after most of the leaves were yellow or dead. The plants produced several side branches that developed normally for a short time and then began to turn yellow and burn along the margins.

VARIETIES

Oak Leaf is the best variety available at the present time and is by far the best for the retail grower to raise. However, there is a demand for Mrs. Paul Ecke because of the size and color of the bracts. Mrs. Paul Ecke is more difficult to grow because it does not develop uniform bracts. Several large bracts and, occasionally, a blind shoot will be found in the same pan. Mrs. Paul Ecke will not stand handling as well as Oak Leaf. Henrietta Ecke is a double variety which has a limited demand. St. Louis and Hollywood are not grown as extensively, because of their cultural difficulty. St. Louis is very easily propagated and develops bracts earlier than Oak Leaf. Barbara Ecke is a new introduction which carries a red cast on the upper sides of the leaves; this variety is deeper red in color than Oak Leaf and requires more time to develop. Ruth Ecke is a sport of Oak Leaf which is superior in freeness of branching after pinching and is similar in color to Christmas Red. This variety produces more bracts and, thus, makes a more double flower. Ruth Ecke should be

grown warmer than Oak Leaf, as it develops more slowly. There are a number of white, cream, and pink variations which are only grown in small numbers.

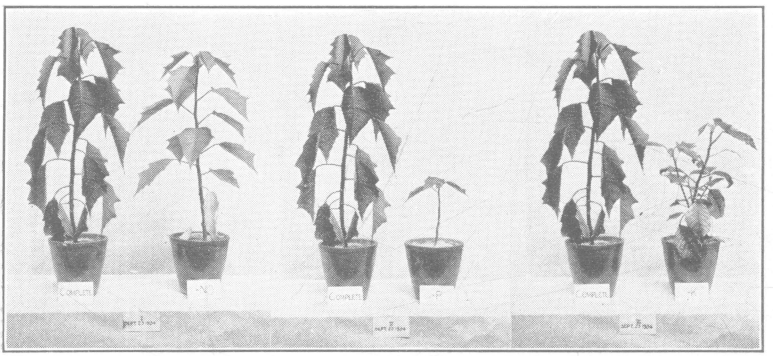

Fig. 11.—Poinsettia nutrient deficiency symptoms. Left—The minus nitrogen test plants were first grown in a complete nutrient solution to obtain enough leaves to show the definite minus nitrogen deficiency symptoms. Center—Shows the effect in minus phosphorus. Right—Potassium deficiency

PRIMULA

The Primulas having the most commercial value are obconica and malacoides. Of the latter, erikssoni, a comparatively new introduction, is far superior to all others for general use. The two Primulas are handled in the same manner, except that malacoides seeds should be sown later than those of obconica. The seeds should be sown in at least three plantings—in February, March, and May. This gives an assortment of sizes at the time of blooming. A seeding mixture of one-half sterilized leaf mold and one-half sand gives satisfactory results.

As soon as three leaves form in the seeding box, the seedlings are transplanted into flats. After the plants have developed to a size for 2¼-inch pots, the stock is potted in a sterilized soil consisting of three parts of soil, two parts of old cow manure, and one part of sand. Primulas must not be allowed to become pot-bound. Bench planting is a good practice. Care should be taken in potting, as getting the plant too deep will cause rotting, and potting too high will cause toppling. Primulas should be grown cool, with a night temperature of 45° to 50° F. When buds begin to show, the temperature may be raised to 60° F. if necessary, to hurry them into bloom. Primulas should have plenty of shade during the summer. In the fall, the shade is taken off and the plants are grown in full sun, as this promotes better quality of flowers. Primulas require an abundance of water, but it is necessary to have a soil which drains well. Primula foliage will turn yellow from lack of drainage, too acid soil, too strong sunlight, and tobacco fumigation.

Fertility deficiency in the soil can be noted in the foliage as follows. Nitrogen deficiency is shown by dwarfed growth and small, light-yellow leaves; phosphorus deficiency, by yellow edges and a sickly green color; potassium deficiency, by large vein development, spotted yellow foliage, and marginal redding.

White flies and green aphis are the common pests of Primulas. Regular spraying will keep the insects under control.

ROSE

Pot roses are very satisfactory subjects for spring sales. They can be used later in the garden, where additional bloom may be secured the same season.

Polyantha or baby ramblers, hybrid teas, hybrid perpetuals, and climbers are all used for forcing. Triple X grade is the most desirable. Rose plants should be secured from some reliable nursery which makes them a specialty. Upon receipt late in November, all except the climbers should be trimmed to 8 to 10 inches above the crown. Only the weak canes are removed from the climbers. Pruning varies with different varieties in the same group. As a rule, low pruning will produce a smaller number of flowering shoots, but will produce longer stems. Low pruning is advocated for hybrid teas to be used for exhibition, but low pruning on polyantha will produce top-heavy plants. All weak stems should be removed at the time of pruning. The size of the roots determines the size of pot to use in potting, whether 5-, 6-, or 7-inch. A slightly acid, fibrous silt loam soil is desirable. A 4-12-4 fertilizer at the rate of a 4-inch pot to a wheelbarrow of soil should be added to the soil before potting.

After potting, store the plants in a cool location, such as a cool greenhouse or cold frame. If the latter is used, cover the canes with straw. In January bring the plants into the forcing house, placing the pots closely together. Syringe frequently to break the buds and, if necessary, place burlap about the canes to encourage more buds along the stem into growth. The temperature and time of starting growth depend upon the Easter date. Plants started January 1 in a temperature of 45° to 48° F. will flower late in March; plants started January 15 will bloom in April. The temperature should be raised gradually to 54° to 56° F. 1 month after starting, and after 6 weeks the temperature should be up to 60° F. Buds should develop in the ramblers 6 weeks before Easter and should show color about 2 weeks before the date required. On hybrid teas and hybrid perpetuals, the bud should form 4 weeks before Easter and should show color a week to 10 days before the holiday.

If plants of hybrid teas and polyantha which fail to develop flowers at the desired time are pruned back to two good five-leaflet leaves, they will come back into flower in 6 weeks. This may be practiced with the leftover plants from Easter to bring them into bloom for Mother's Day or Memorial Day.

The baby ramblers include the following varieties: Edna Teshendorf, Gloria Mundi, Golden Salmon, Greta Kluis, Ideal, Miss Edith Cavell, Orange King, Orleans, and Verdun.

The best of the hybrid teas are Countess Vandal, Dame Edith Helen, Etiole de Hollande, E. G. Hill, Mme. Edouard Herriot, Pres. Hoover, Texas Gold, Souvenir de Claudius Pernet, and Talisman. All teas are hard to time exactly, and under unforeseen conditions of extreme sunlight may bloom much too soon.

Hybrid perpetual varieties include Frau Karl Druschki, American Beauty, and Magna Charta.

The better climbers are Crimson Rambler, Eugene Jacquet, Excelsa, Dorothy Perkins, Rosary, and Tausendschoen.

Mildew and black spot are prevented by vaporizing sulfur painted on the steam lines or dusting with fine dusting sulfur. Red spider, aphids, and thrips are often troublesome pests.

SAINTPAULIA

Saintpaulias, with their long blooming season, offer a satisfactory subject for forcing. A native of tropical Africa, the Saintpaulia makes a satisfactory house plant. It requires comparatively little light, does well in the dry atmosphere of the average home, and if not overwatered will continue to flower satisfactorily for a long period.

Saintpaulias do much better if grown in houses where there are no other crops. Grown in this way they are always under control. Small, low houses are preferred to large, high ones, but closeness of atmosphere is not desirable.

Only the firm, mature leaves should be used for propagation. Several different methods of leaf propagation are in general practice. The petiole cutting is gradually being supplanted by the leaf cutting. The leaf is cut at the base and inserted into a clean propagating medium. This method produces plants with a number of crowns and results in more uniform stands. After cutting, the leaf is soaked for 5 minutes in a solution of colloidal sulfur mixed at the rate of 3 teaspoons to 1 gallon of water. This treatment will prevent the spread of mites from the cutting to the new plant. Sand, cinders, and slag are good media for propagating the Saintpaulia. A bottom temperature of 65° to 70° F. will produce earlier rooting. In the spring, about 4 to 8 weeks are necessary for the small rosettes to grow to a size large enough to pot into 2¼-inch pots.

From 5 to 6 months after the cuttings have been started the plants are blooming and ready for the retail florist and his customer.

SOIL MIXTURES

During the past few years a series of soil experiments has been conducted with the following soil mixtures:

Plot 1. Compost soil
Plot 2. Compost soil plus one-fourth leaf mold
Plot 3. Compost soil plus one-fourth rotted manure
Plot 4. Compost soil plus one-fourth German peat

Ten plants of *S. ionantha* in 4-inch pots were in each plot.

The results showed that Plot 2 (soil plus one-fourth leaf mold) was superior to the other plots in producing larger plants with more flowers. Plots 3 and 4 were just a trifle inferior to Plot 2.

Soil for the smaller-size plants should be made lighter by the addition of sand to the mixture. All soil and pots should be sterilized before using; steam is superior to the other types of sterilization. It should be remembered that a small amount of well-rotted manure should be added to provide the necessary bacteria which are killed by sterilizing the soil.

Watering is particularly important with Saintpaulias. They should be kept moist at all times, but not soaked. There is more trouble from overwatering than from underwatering. Getting water on the foliage should be avoided as much as possible.

The young plants are allowed to remain in the original pots until a mass of young growth comes up at the base of the cutting. During this time the plants should be watched closely and spaced properly to prevent rotting of leaves and centers. The plants are then shifted into 3-inch pots. They may later be shifted to 4-inch or 5-inch pots if larger sizes are desired.

The commonest pest on *Saintpaulia ionantha* is the cyclamen mite *(Tarsonemus pallidus* Banks). Plants injured by mites are dwarfed; the leaves are reduced in size, cupped upward, or rolled downward, and have conspicuously dense, whitish pubescence on the upper surface. Opening flowers are malformed; buds are prevented from opening; and flower production finally ceases.

Smith (7) reported an undetermined malady which spreads in the greenhouse, appears in vegetative propagations from affected plants, and causes symptoms of stunting and flower suppression that are confused with mite injury. This trouble, which has been called stunt, is differentiated by the presence of hard, brittle, thickened leaves with suppressed pubescence and upward-rolled margins.

Another abnormality of undetermined cause is that of yellow ring spots of various patterns appearing on leaves exposed to too intense sunlight. If the plants are properly shaded, these symptoms are masked on new growth. Shading is the only commercial method used in preventing this abnormality in growing stock.

Mites are partially controlled by submerging the leaves in the sulfur bath at the time of propagation, followed by nicotine sulfate spraying and constant roguing of infested plants. Spraying every evening with a solution of nicotine sulfate at the rate of 1 ounce to 1 quart of water is recommended. The solution is used in a hand sprayer and is sprayed, not directly on the foliage, but as a mist in the air over the plants, to insure incorporation of moisture and air before the spray reaches the plants.

Smith (7) found that immersing plants for 15 minutes in water at 110° F., or for 20 minutes at 108° F., supplemented by isolation to prevent reinfestation, gave good control of cyclamen mite. This method is attendant with danger and should be used with caution.

Gradually remove the shade in October and have it completely removed by November. Start shading lightly during February, and as the light intensity increases add more shading.

Ventilation and heating are very important. Avoid stagnant, close atmosphere. The night temperature should be 60° to 62° F., with an increase of 8 to 10 degrees during the day. Plants grown in too cool a temperature will develop epinasty (curving downward).

Saintpaulia ionantha is still a favorite with many growers but many new varieties are being added. Blue Boy, which has dark-blue flowers with short, light-green leaves, will mature 1 month earlier than ionantha. Sailor Boy is similar to Blue Boy, but its flower color is light blue, and its foliage is darker. Viking, Neptune, Norseman, The Admiral, and Amethyst are other new varieties that are worth growing in a limited quantity. Ionantha, Sailor Boy, and Viking are the three most popular varieties.

YELLOW CALLA (ZANTEDESCHIA ELLIOTTIANA)

The Yellow Calla is a desirable potted plant for Easter sales. Rhizomes are grown in numbers in California and generally received in Ohio in November.

When the rhizomes arrive, unpack them and place them in a flat, giving them plenty of air. Place the flats in a temperature of 90° F. until planting time, which is from December 15 to January 1. This warm condition encourages quicker starting. After the heat treatment, plant the rhizomes in a flat, using imported peat moss in place of soil. The flats may be placed under a bench in a warm house. After sufficient root growth has resulted, pot into 5- or 6-inch pots, depending on the original size of the rhizome. For best results, temperatures of 60° F. or higher are best.

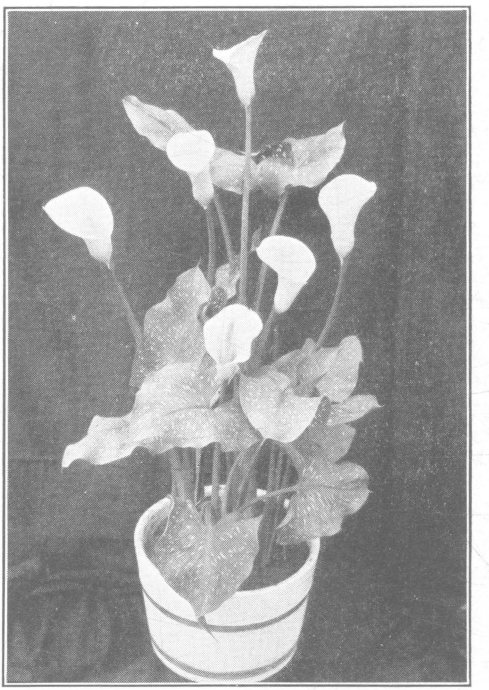

Fig. 12.—Yellow Calla. Grown singly in 5-inch pots and later planted in a wooden tub

Soil to which one-fourth well-rotted manure has been added, plus a 4-inch pot of 4-12-4 to the wheelbarrow of soil, has given good results.

After the flower is visible the plants will keep for several weeks when placed in a cool temperature. Small-size rhizomes will flower as well as the larger sizes, but the flowers are usually smaller. Applications of a liquid urea, 1 ounce to 5 gallons of water, every 2 weeks increase the size of the flower.

Leftover plants should be kept growing during the summer and given a slight drying-off period in September and October.

The yellow calla is troubled with root rot and soft root. Discarding the rhizomes which show rot and treating the sound-appearing ones for 1 hour in water, then for 1 hour in a solution of bichloride of mercury, 2 ounces to 7½ gallons of water, before planting is beneficial in preventing these diseases. Care should be taken to use a wooden or earthenware container in this treatment.

COSTS OF PRODUCTION

During the past few years cost figures have been obtained from pot plant growers cooperating and recording all expenditures and receipts under a system devised at the Ohio State University.

Table 10 indicates the average cost of operation of a pot plant range per square foot of bench space per year. The actual growing space in the bench has been considered. It should be realized that modification should be made for different localities because of methods of culture, wages paid, price of coal, prevailing temperatures, constant occupancy of available space, losses from disease and insects, and other factors.

Labor has been computed on the basis of $20 per week for common workmen; to this the cost of supervision by the foreman has been added. Interest on investment and depreciation have been calculated at 6 per cent each. Coal has been averaged at $4.50 per ton, and the quantity used has been 1 ton for every 100 square feet of glass area.

TABLE 10.—Average Figures for Computing Greenhouse Operations Costs per Square Foot

	Cents		Cents
Labor	36	Taxes	3
Interest on equipment and notes	10	Insecticides and fungicides	2
Depreciation on greenhouses and tools	6	Fertilizers	2
Coal	8	Soils	2
Repairs and improvements	4	Supplies (stakes, string, etc.)	2
Water and electricity	3	Miscellaneous	2
		Total	80

The average annual operating cost per square foot of bench space was found to be 80 cents. By using this figure as a basis, every grower is enabled to compute the cost of production of any crop grown. All that is necessary is to determine the length of time the plants were grown on a certain space in the bench, and then figure the cost from the yearly average indicated. The figure given does not include marketing costs.

Lower production costs are frequently obtained. They are attributed to extreme intensiveness of production, a result of proper and complete rotations, and comparatively small losses from diseases and insects. Cheap fuel and low labor costs also may be contributing factors.

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